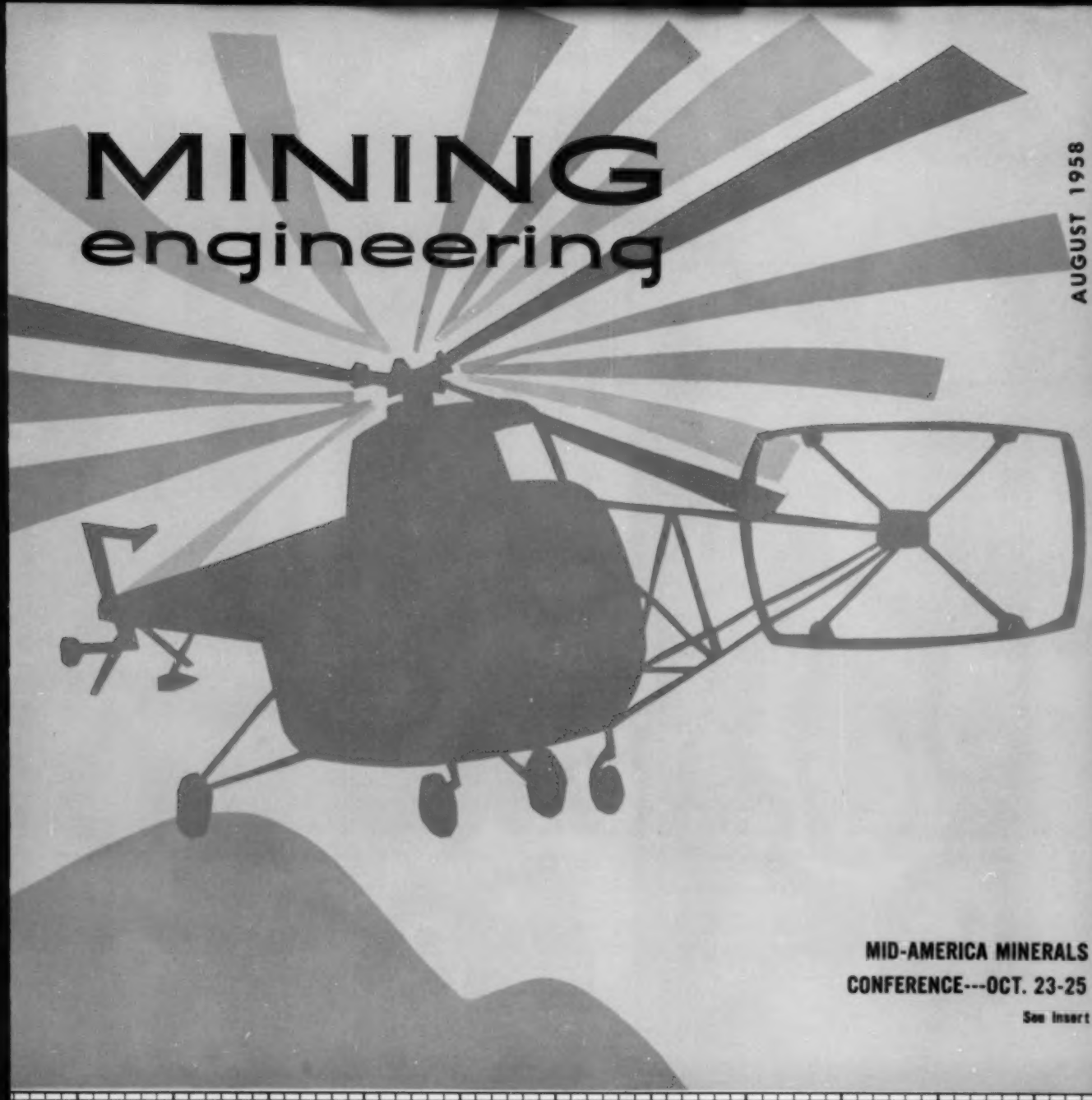
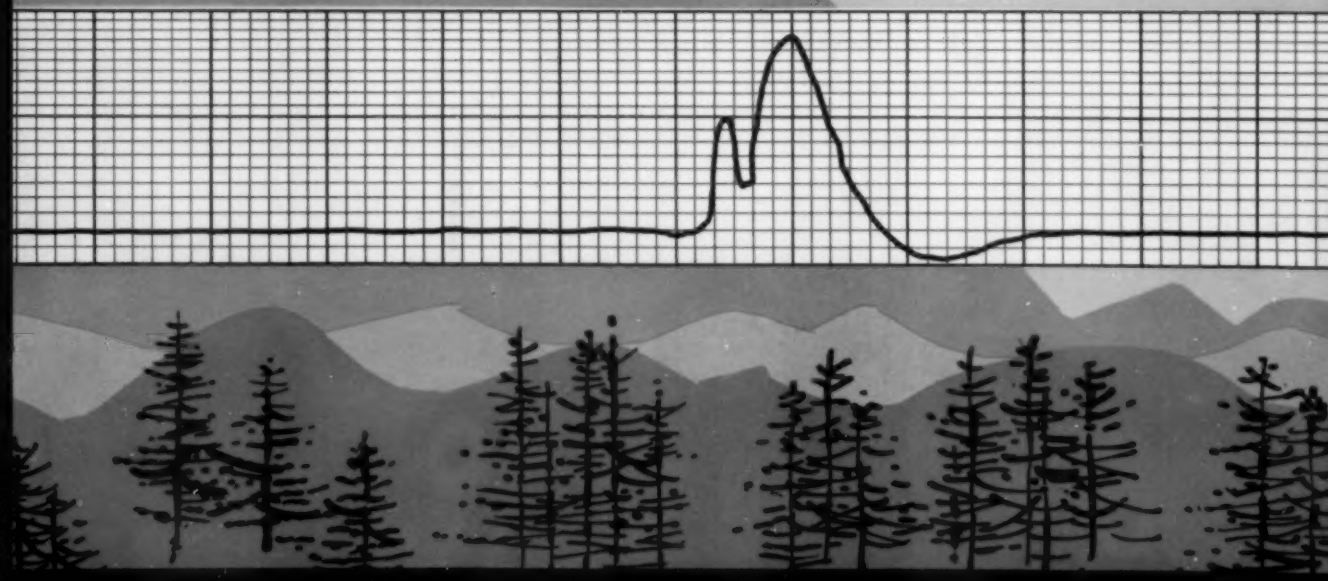
MINING engineering

AUGUST 1958



MID-AMERICA MINERALS CONFERENCE---OCT. 23-25

See Insert



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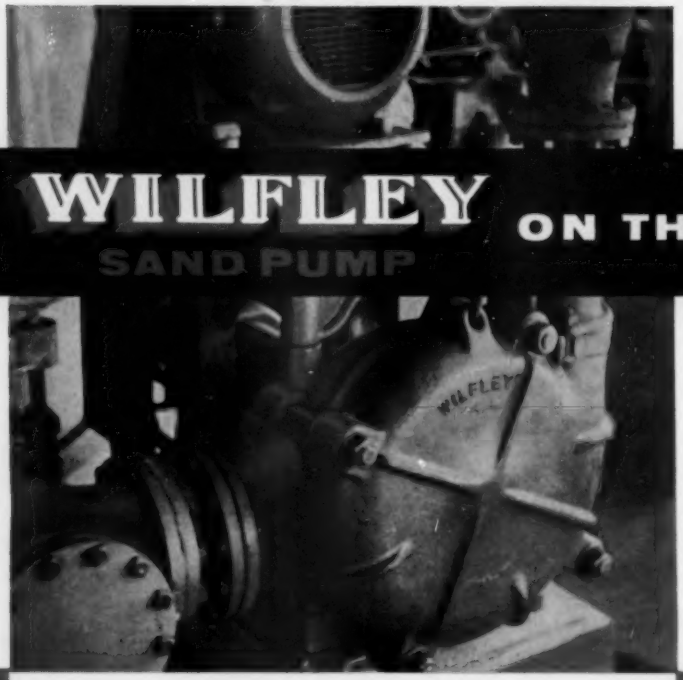

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COMING EVENTS

Aug. 23, AIME Adirondack Section, golf and speaker, Tupper Lake, N. Y.

Sept. 2-6, UPADI, 5th convention, Montreal.

Sept. 7-11, Sixth World Power Conference, Montreal, with field trip Sept. 11-15.

Sept. 13, AIME Colorado Plateau Section, Aspen, Colo.

Sept. 16-19, Sixth International Congress on Large Dams, New York.

Sept. 17-19, AIME Rocky Mountain Minerals Conference, Newhouse Hotel, Salt Lake City.

Sept. 18-20, Rocky Mountain Assn. of Geologists, symposium on Pennslyvanian rocks of Colorado and field trip, Maroon Basin, northwest Colorado.

Sept. 20 (tentative), AIME Lehigh Valley Section, tour of "Nike" site, Doylestown, Pa.

Sept. 22-25, American Mining Congress Mining Show, Civic Auditorium, San Francisco.

Sept. 27, AIME Adirondack Section, National Lead trip, Tahawus, N. Y.

Oct. 2-4, Annual Drilling and Blasting Symposium, University of Minnesota, Minneapolis.

Oct. 4, AIME Eastern North Carolina Subsection, Southeast Section, Carolina Inn, Chapel Hill, N. C.

Oct. 9-10, AIME-ASME Solid Fuels Conference, Hotel Chamberlin, Old Point Comfort, Va.

Oct. 9, 10, ECPD annual meeting, Sheraton-Jefferson Hotel, St. Louis.

Oct. 13-16, Soc. of Exploration Geophysicists, annual meeting, Gunter Hotel, San Antonio, Texas.

Oct. 15-17, Energy Resources Conference, Brown Palace Hotel, Denver.

Oct. 16, AIME Utah Section, speaker: L. V. Olson; subject: Progress in Air Pollution Control; Salt Lake City.

Oct. 16-18, 9th Annual Field Conference, New Mexico Geological Soc. in cooperation with Arizona Geological Soc., Black Mesa Basin of northeastern Arizona.

Oct. 20-23, National Clay Conference, Natural History Bldg., Smithsonian Inst., Washington, D. C.

Oct. 23-25, AIME Mid-America Minerals Conference, Chase-Park Plaza Hotels, St. Louis.

Oct. 24, AIME Lehigh Valley Section, technical meeting, Hotel Traylor, Allentown, Pa.

Oct. 31-Nov. 1, AIME Central Appalachian Section and West Virginia Coal Mining Inst., joint meeting, The Greenbrier, White Sulphur Springs, W. Va.

Nov. 7, AIME Pittsburgh Section and AIME NOHC Pittsburgh Section, 13th annual Off-the-Record Meeting, Principal speaker: G. B. Warren, General Electric Co.; Penn-Sheraton Hotel, Pittsburgh.

Nov. 13-14, Missouri School of Mines and Metallurgy, 4th annual symposium on mining research, University of Missouri, Rolla, Mo.

Dec. 1, AIME Arizona Section, annual meeting, Pioneer Hotel, Tucson, Ariz.

Dec. 5, AIME Lehigh Valley Section, ladies' night, Speaker: Augustus B. Kinzel; Lehigh Valley Club, Allentown, Pa.

Dec. 6, AIME Eastern North Carolina Subsection, Southeast Section, Hotel Vance, Henerson, N. C.

Dec. 11, AIME Utah Section, panel discussion on Place of Research in the Minerals Industries; members: chairman J. M. Ehrhorn, S. R. Zimmerley, J. B. Clemmer, W. M. Fassell, Jr., J. R. Lewis; Salt Lake City.

Feb. 15-19 1959, AIME Annual Meeting, Sheraton-Palace, St. Francis, Sir Francis Drake Hotels, San Francisco.

Apr. 5-10, EJC 1959 Nuclear Congress, Public Auditorium, Cleveland.

MINING engineering

Vol. 10 NO. 8 **AUGUST 1958**

COVER *New exploration techniques, such as the aerial electromagnetic method depicted by artist Herb McClure on the cover, continue to command attention from mineral engineers. M&E is preparing for presentation of technical papers on this subject at San Francisco in February 1959—**see page 901.*

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Geologist, geological engineering degree, age 29. Two years experience as geologist in open pit copper mine with some exploration work. Location, immaterial. M-435.

Exploration Geologist, B.S. in geological engineering, age 30. Three and one half years in exploration and resident geological work; some open pit mining experience. Surface and underground mapping, property evaluation. Familiar with geology of western U. S. Practical underground mining and experience in steel fabrication. Location, immaterial. M-1548-SF.

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Mill Shift Bosses, preferably technical graduates, single, with minimum of three years experience in gold cyanide milling, also with Latin American experience. Duties will consist of shift work operating cyanide gold mill with lead flotation circuit. A working knowledge of Spanish is essential. Salary, $4200 year, plus approximately 2½ months extra pay per year in benefits imposed under local labor laws. Location, South America. F6276.

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Research Metallurgist, ore beneficiation, to 45, metallurgist or mining engineer, well trained in metallurgy, with aptitude and interest primarily research, to improve current practice in 100-tph copper flotation mill and test various grades and mixtures of massive sulfide ores. Three-year contract. Salary, open. Submit complete record and references with first reply. Location, Mediterranean area. F5884S.

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Mine Foreman, for underground mine operations; B.S. in mining engineering and at least three years experience in supervisory position such as assistant mine foreman. Must have qualifications for future advancement. Three-year contract with transportation both ways and salary

(Continued on page 834)

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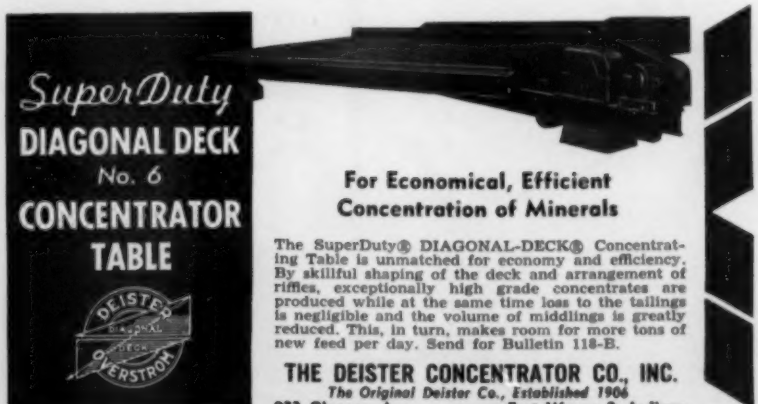

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20	M.S. Connectors	$ 10.51
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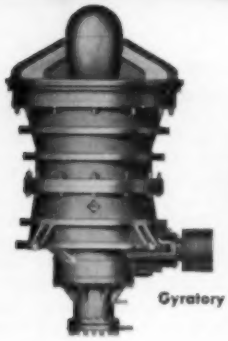
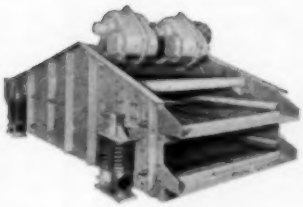


Gyratory Crushers



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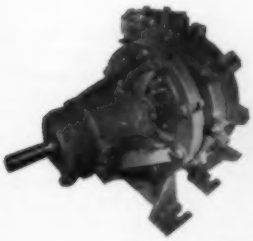

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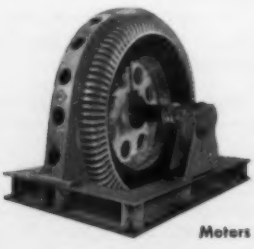
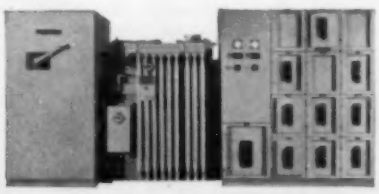


Motors



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A Guide to Graduate Study, edited by Frederic W. Ness, *Assn. of American Colleges,* distributed by American Council on Education, 1785 Massachusetts Ave. N.W., Washington 6, D. C., 335 pp., $5.00, 1957.—A survey of facilities, including schools of engineering, available to the person interested in securing a doctorate. After a preliminary portion touching on various aspects of graduate study such as choice of vocation and selection of school, the main section consists of a directory of graduate schools with pertinent information on admission requirements, fees, fields of study, etc. • • •

Once Round the Sun: The Story of the International Geophysical Year, by Ronald Fraser, *The Macmillan Co.,* 160 pp., $3.95, 1957.—Because of the importance of the sun in the study of geophysics, various phases of the sun's behavior are discussed in this book. The program of the International Geophysical Year is covered in detail: the 24-hr watch on the sun, the oceanographic program, and the concentration of stations throughout the earth. • • •

Third Annual Symposium on Mining Research, Bulletin No. 95, *Missouri School of Mines,* University of Missouri, Rolla, Mo., 158 pp., 1958.—This bulletin presents the proceedings of the Third Annual Symposium on Mining Research, held at the University of Missouri, School of Mines and Metallurgy, on Nov. 14 and 15, 1957. The symposium, sponsored by the University and the U. S. Dept. of Interior, Bureau of Mines, was presented as one of a series of such conferences which are dedicated to the spreading of knowledge of pertinent new scientific and industrial developments to all segments of the mining profession.

While the scope of the subject matter to be offered at successive meetings may embrace the whole of the field of mining research and development, each individual symposium is designed to present problems of current interest to professional men from government agencies, the mining industry, and mining schools. In the current symposium the topics center around blasting development, particularly the extensive use of AN-fuel oil explosives. Ventilation, drilling, and dust-collection problems are explored, particularly with reference to the application of basic science and modern instrumentation methods to their solution. There are numerous tables and figures.

Contracts, Specifications, and Law for Engineers, by Clarence W. Dunham and Robert D. Young, *McGraw-Hill Book Co. Inc.,* 550 pp., $7.50, 1958.—The authors of this book attempt to state basic legal principles of the law of contracts simply and clearly, rather than quoting from involved court decisions or complicated legal documents. These principles are discussed as they apply to construction contracts in particular, but various other fields of law of special interest to the engineer are also considered. • • •

The Deformation of the Earth's Crust, by Walter H. Bucher, *Hafner Publishing Co. Inc.,* 31 E. 10th St., New York 3, N. Y. 518 pp., $10.00, 1957.—A reissue of an important work that has been out of print for several years. A new preface by the author gives references to significant publications which have appeared since the original edition was published in 1933. • • •

Le Sahara, by Raymond Furon, *Payot,* Paris, France, 300 pp., approx. $4.80, 1957.—In connection with the ever-expanding hunt for natural resources, this book deals with an area which has only recently been given much attention. It covers the general and regional geology of the French Sahara; describes the results of mineral exploration; and discusses the difficulties and possible results of the economic exploitation of the resources of this immense territory. • • •

A Treatise on the Internal Mechanics of Ball, Tube, and Rod Mills, by H. E. Rose and R. M. E. Sullivan, *Chemical Publishing Co. Inc.,* 212 Fifth Ave., New York 10, N. Y., 258 pp., $6, 1958.—The internal mechanics of mills are studied in relation to the motion of the mill charge; the power to drive a mill; the comminution of solid bodies; the process of grinding, surging, and vibration in a mill; metal wear in mills; and the role of additives in milling. • • •

1957 Supplements to Book of ASTM Standards, *American Society for Testing Materials,* 1916 Race St., Philadelphia 3, Pa., 7 parts, 2521 pp., $4.00 per part or $28.00 per set, 1957.—These supplements to the triennially published *Book of ASTM Standards* give in their latest form 415 specifications, tests, and definitions which either were issued for the first time in 1957 or revised since their appearance in the 1955 Book or the 1956 Supplements. The subjects covered include: Ferrous Metals; Non-Ferrous Metals; Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing, Soils; Fuels, Petroleum, Aromatic Hydrocarbons, Engine Antifreezes; and Rubber, Plastics, Electrical Insulation. • • •

Metals and Men, by D. M. LeBourdais, *McClelland & Stewart Ltd.,* 25 Hollinger Rd., Toronto 16, Ont., Canada, 416 pp., $8.50, 1957.—A record of the discovery and development of mines in Canada. • • •

(Continued on page 837)

Progress in Mineral Dressing, Transactions of The International Mineral Dressing Congress in 1957, *Almqvist & Wiksell,* Gamla Brogatan 26, Stockholm, Sweden, 750 pp., 95 kr. (approx. $18.40), 1958.—Transactions of the 1957 conference covers all aspects of mineral dressing from comminution to chemical processing.

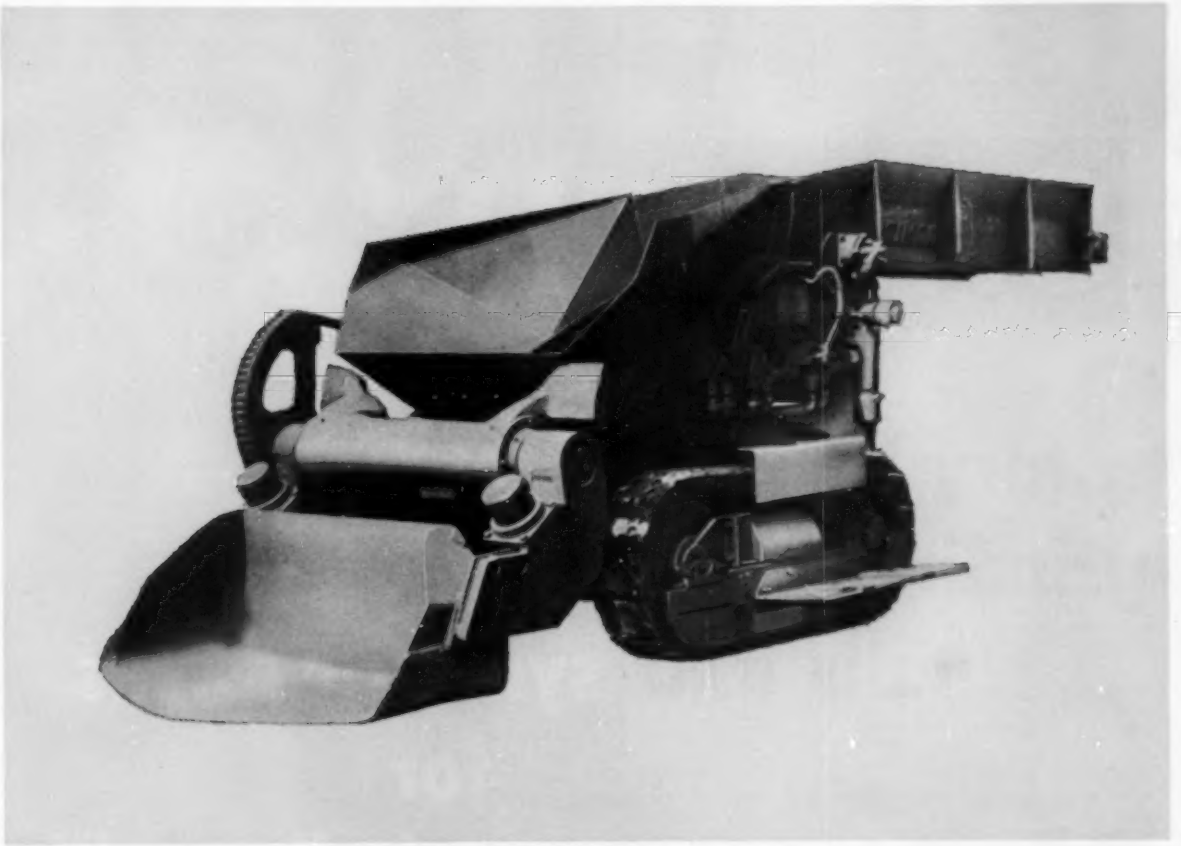
Swedish Mineral Dressing Mills, compiled by Ernst Rothelius, *International Mineral Dressing Congress,* Nackstromsgatan 1[III], Stockholm C, Sweden, 210 pp., $6.25, 1957.—Description of 24 Swedish mineral dressing mills was issued at the time of the 1957 conference. Data for the book was furnished by the plant authorities.

Personnel

(Continued from page 830)

while traveling. Location, South America. F5973(b)

Field Sales Engineer, for multi-division company to cover northeastern territory out of New York. Will be responsible for process equipment sales to the metallic and nonmetallic industries and must have three to five years experience in processing equipment field. College degree in metallurgy or minerals beneficiation preferred. Liberal benefits.



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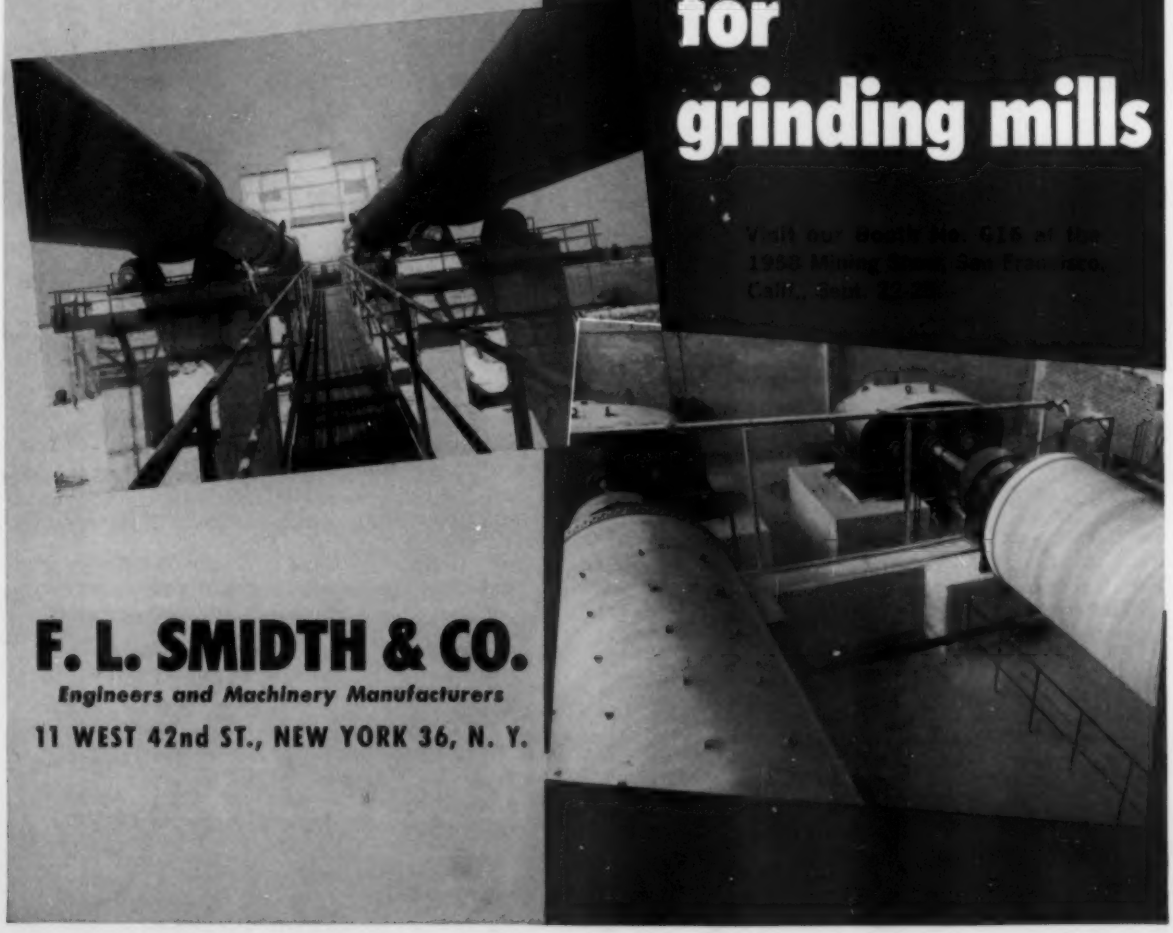

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Books

(Continued from page 834)

State Publications

California Journal of Mines and Geology, vol. 54, No. 1, *California Dept. of Natural Resources, Div. of Mines*, Ferry Bldg., San Francisco 11, Calif., 205 pp., $1, 1958.

Directory of Coal Producers in Indiana, by C. E. Weir, Directory 5, *Geological Survey*, Publications Section, Indiana Dept. of Conservation, Indiana University, Bloomington, Ind., 100 pp., 1 plate, 3 figs., 1 table, 75¢, 1957.

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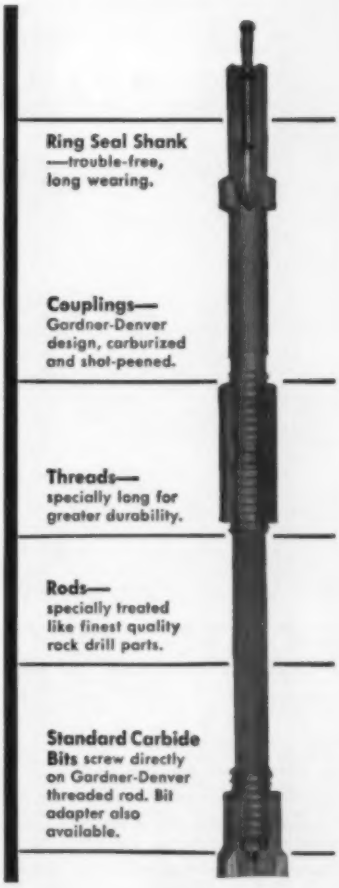
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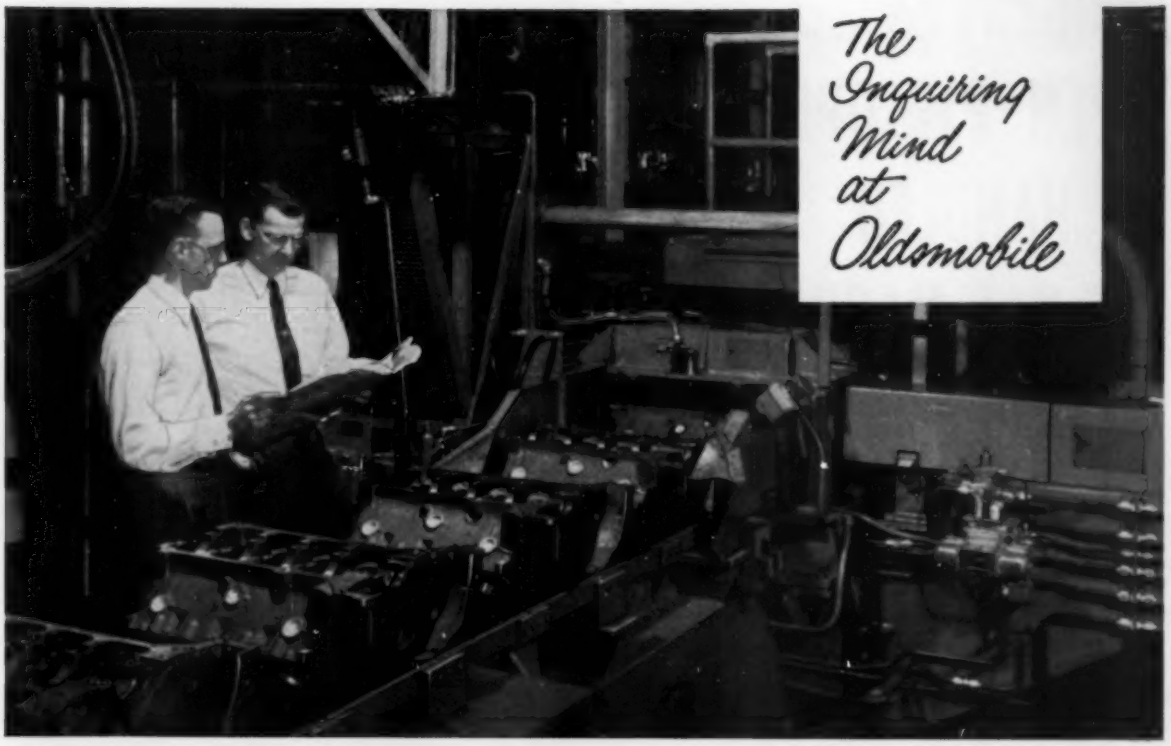

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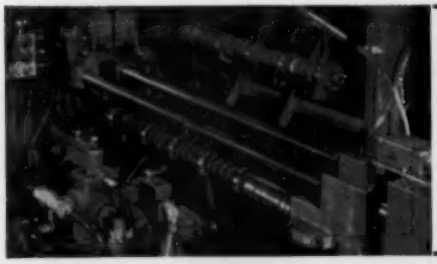

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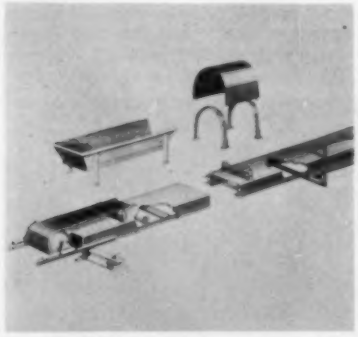

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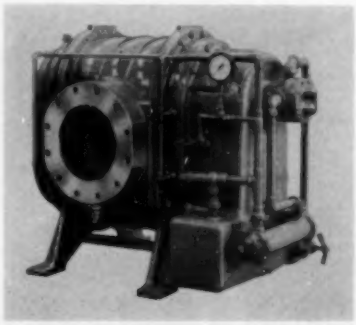
Roots-Connersville Blower has introduced a new blower, type RAS, designed to save up to 40 pct in floor



space through a vertical arrangement of impellers which also provides horizontal inlet and discharge connections. Units are sized for direct connection to moderate and high speed motors. Flanged stub shaft design permits high pressure rating for given impeller length to deliver greater displacement without extra high rotating speeds. **Circle No. 5.**

Herringbone Wire Rope

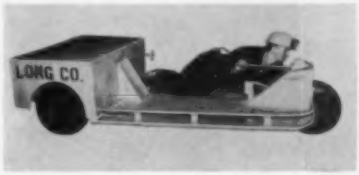
John A. Roebling's Sons Corp. has combined regular lay and Lang lay strands to produce new Herringbone wire rope. The company says test results indicate superior flexibility, good resistance to shock and abrasion, smooth operation around drums and sheaves, easy spooling properties, and exceptional structural stability. **Circle No. 6.**

Loudspeaking Mine Phones

Personnel can page each other over loudspeakers, then converse in voice tones through a telephone handset with new self-contained station units by *Femco Inc.* Systems use existing mine phone lines and are designed for clear communication over heavily loaded, noisy lines. Sets are completely transistorized and battery-operated. **Circle No. 7.**

Utility Car

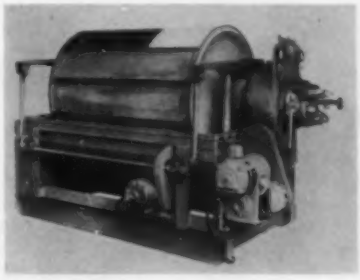
Coal mine inspectors will find a friend in a new 3-wheeled utility car by *Long Co.* Car carries 500 lb plus operator, operates two full shifts



between battery charges, and is made in three tramming heights—24, 36, and 60 in. Speed is 4 mph. **Circle No. 8.**

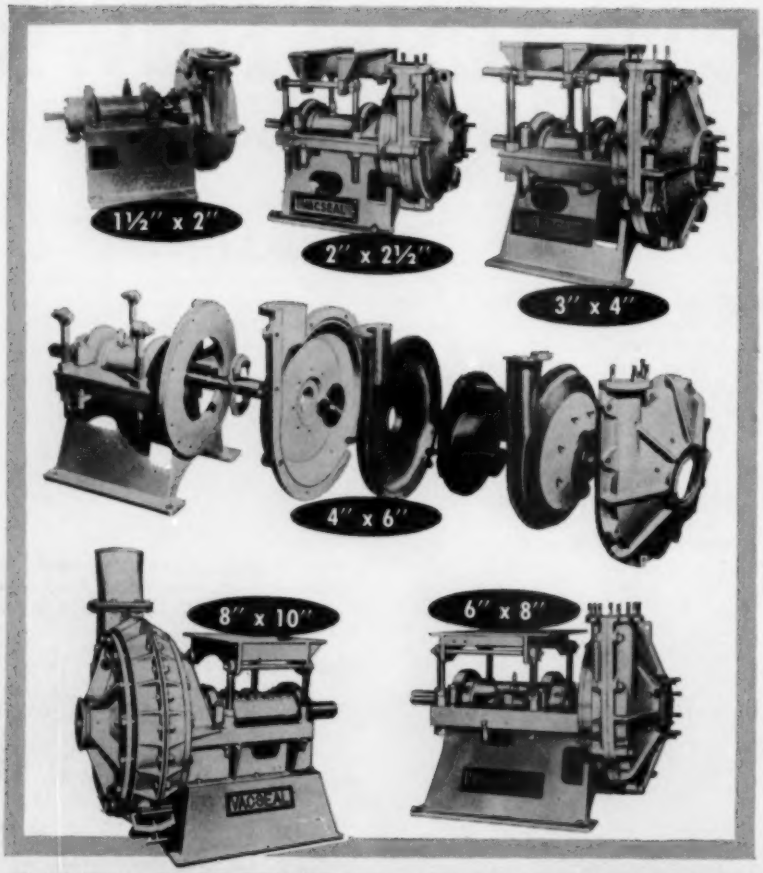
Plastic Drum Filter

Dorr-Oliver Inc. has found a way to cut costs in filter applications encountering mild corrosives by use of a Fiberglas drum filter instead of more expensive rubber covered or stainless steel machines. First of its kind, the rotary drum vacuum unit permits continuous operation at up to 170°F. Longitudinal surface sections are drained through molded rubber grids which can be snapped in and out of place for inspection or replacement. **Circle No. 9.**



Jackhammer

Ingersoll-Rand's new rock drill, designated the J-30A Jackhamer incorporates blower valve into throttle valve for ease in clearing cuttings. Almost all parts are interchangeable with earlier J-30. **Circle No. 10.**



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3" x 4"	150- 500 gpm	Up to 110 feet	8" x 10"	800-3600 gpm	Up to 150 feet

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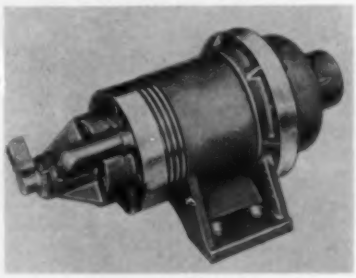
Air Motor-Vibrator

The model LAV air motor by *Dart Mfg. & Sales Co.* doubles as a general utility motor and, with a vibrator bell, as an external vibrator with



a range of 0 to 10,000 rpm from one simple manual control. Normal rating is 3 hp, weight is 36 lb. **Circle No. 11.**

Nitrate Cans

Tin plate and steel containers for protecting ammonium nitrate blasting agents from water are offered by *Vulcan Containers Inc.* Air tested against leaks, the containers have heavy wire carrying grips and are made in 4¼ to 10¼-in. diam. Double friction top tin plate cans are 16¾ in. long; 24-in. steel cans have double seamed tops with 73 mm opening for easy filling. **Circle No. 12.**

Wide Vibrating Screen

The newest *Allis-Chalmers* run-of-mine vibrating screen is the 8x14-ft double-deck, floor-mounted model XXH featuring a cartridge type

mechanism for easy removal. Unit shown is handling 7-in. limestone and making 5½ and 3-in. separations with peak loads up to 1760 tph. **Circle No. 13.**

News & Notes

A recent Chicago telecast of the "Ticker Tape" program of station WTTW put spotlights on the rapid growth and future potential of *Gardner-Denver Co.* . . . *Allis-Chalmers* will start operating a prototype model of its grate-kiln system for agglomeration and heat treating this fall. . . . *Yuba Consolidated Industries Inc.* has purchased Judson Pacific-Murphy Corp., a steel fabricator. . . . *U. S. Electrical Motors Inc.* celebrates its 50th Anniversary this year. . . . *Dorr-Oliver Inc.* has incorporated three Stamford, Conn., offices into a new 120,000 sq ft building. . . . *Joy Mfg. Co.* has formed Joy International, S. A., a wholly-owned subsidiary to handle overseas activities.

FREE LITERATURE

(21) FLOTATION FUNDAMENTALS: *Dow Chemical Co.* has issued a completely revised edition of its "Flotation Fundamentals" handbook. The 107-page book contains data on flotation processes and agents, new Dow flotation agents and mining chemicals, applications, and ore testing. It also includes comparative metallurgical data, a listing of mineral properties, and handy reference conversion factors.

(22) MANAGEMENT INFORMATION: Executives seeking to make their supervision more purposeful will find down-to-earth help in a service by *Elliott Service Co. Inc.* "Management Information," intended to help foremen and supervisors think and act like the management they represent, is covered in detail in an interesting brochure called "New Horizons for Supervision."

(23) KILNS, COOLERS, DRYERS: *Traylor Eng. & Mfg. Co.* has 36-page illustrated bulletin 1115, which describes in full detail a versatile line of rotary kilns, coolers, and dryers. The processing equipment is shown in a wide variety of on-the-job applications.

(24) CONVEYOR BELTING: *Quaker Rubber Div.*, H. K. Porter Co., offers a loose-leaf specification brochure covering conveyor, elevator, and transmission belting. Some specialized types are intended for mucking, handling hot and abrasive materials, running at high speeds.

(25) OVERDRAIN CLASSIFIER: *Hardinge Co.* offers 4-page bulletin AH-478 on its latest development, the Overdrain classifier. Unit's closed compartment belt system with overdrain holes—to keep surplus liquid and slimes discharge from mixing with oncoming sand—results in clean sand discharge and excellent desliming, reports Hardinge.

(26) DIAMOND DRILL BITS: *J. K. Smit & Sons Inc.* has a catalog of diamond drill bits that also includes a list of do's and don'ts in diamond

drilling and a table of core bit recommendations. Coring, concave, pilot, and casing bits are covered along with ring and strip type reaming shells.

(27) BELT REPAIRING: *Automatic Vulcanizers Corp.* has a new manual showing how conveyor belt repairs can be made with Pang cold self-vulcanizing material without heat, pressure, or machines. Material cures into a tough resilent rubber at room temperature within hours.

(28) ROOF BOLTS: *Republic Steel Bolt & Nut Div.* has a brochure describing Republic square head, forged steel wedge head, and slotted mine roof bolt assemblies, as well as roof bolt plates. Quality steel is the "constant factor" in roof bolting, says Republic.

(29) VIBRATING CONVEYORS & PROCESSING EQUIPMENT: Bulletin 112 details the "Natural Frequency" operation of *Carrier Conveyor Corp.* vibrating equipment that permits more work per power unit input. Conveyors are available in widths from 6 to 48 in. and lengths from 5 to 200 ft.

(30) TRACTOR-SHOVELS: *J. I. Case Co.* has a brochure covering the models 800 and 1000 Terratrac crawler-mounted tractor-shovels. Units feature torque converter drive, torsion-bar track suspension and load equalization, automatic track lubrication.

(31) MINING CABLES: Bronco neoprene "66" heavy cables engineered for mining use are detailed in a new folder from *Western Insulated Wire Co.* Various types are all oil and impact-resistant, flameproof, highly flexible. Jackets have more than 67 pct neoprene content.

(32) CARBIDE MINING TOOLS: A 20-page booklet, "Carmet Carbide Mining Tools," lists all standard tools of *Allegheny Ludlum Steel Corp.* Seven new tools are covered. Brief section includes reconditioning procedures with detailed drawings.

(33) BIN DEVICES: A consolidated catalog is available for three products made by *Bin-Dicator Co.* for bulk material level indication and control. Described in detail are the Bin-Dicator, diaphragm type bin level indicator; Roto-Bin-Dicator, rotating paddle type bin level indicator; and Bin-Flo Aerator, to promote flow of dry, finely ground bulk materials.

mail this post card for more information

8

Mining Engineering **29 West 39th St.** **New York 18, N. Y.**

Not good after November 15, 1958—if mailed in U. S. or Canada

Please send { More Information ☐ / Price Data ☐ / Free Literature ☐ } on items circled.

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61	62	63	64						

Students should write direct to manufacturer.

(34) INDUSTRIAL TRACTORS: Newly styled rugged 440 series wheel or crawler type tractors by *John Deere* are specified in a new color folder. Engines rate at about 29 hp.

(35) WIRE ROPE USE: *Wire Rope Corp. of America* has a new 36-page handbook covering the selection of wire rope for specific needs, methods of socketing, splicing, and installation as well as important safety points.

(36) USED EARTHMOVERS: Particulars of *Caterpillar* dealer's bonded used equipment values under three guarantees are included in a new 8-page booklet, "For Used Equipment You Can Trust."

(37) SCRAPING: Versatility is the keynote in combining crescent scrapers with tractors according to a field report from *Sauerman Bros. Inc.* Bulletin SND 209 shows how the combination handles small yardages at low cost.

(38) SPECIALTY STEELS: *Crucible Steel Co. of America* has a 12-page brochure covering specialty steels for the mining and heavy construction industries. Various grades of alloy, carbon, drill, stainless, and tool steels are among the related items included. Recommended technical manuals and aids are also described.

(39) FEEDERS: Geary reagent feeder types A, B, C, and Junior are covered in a brochure available from *Galigher Co.* Outline drawings and dimensions are included.

(40) DIESEL CRAWLER: New 14-page catalog MS-1289 from *Allis-Chalmers* points up features of the HD-16 crawler tractor. Cutaway view details both gear transmission and torque converter models. Available matched equipment is described.

(41) FILTERS: Bulletin 5710 from *Morse Bros. Machinery Co.* supplies data on a line of continuous vacuum drum and disc filters.

(42) DRILL RIG: A single sheet bulletin, DRB-101, from *Carpco Mfg. Inc.* gives details on new Jet drill rigs for sampling of beach mineral deposits.

New Films

The third film in Inco's documentary of nickel operations is now available. *Refining Nickel from the Sudbury Ores* covers both the carbonyl and electrolytic methods of recovery in 52 min of action photography, stop motion, and animation. The clear and complete film story is mounted on one 2000-ft reel available from *International Nickel Co.* through *Rothacker Inc., 729 Seventh Ave., New York 19, N. Y.* Give three date choices when requesting a print reservation or ask for a brochure complete with order form and further information.

Hold That Roof, a new 27-min sound film in color, produced by *Ohio Brass Co., Mansfield, Ohio,*

supplies suggested installation procedures for safe roof bolting. Animated cartoons and on-the-spot underground photographs are used to explain current theories of roof support, correct installation, hole size, installed tension, torque, safety checks. Film is available through O-B representatives along with a 20-page, pocket-size booklet of safety reminders for each member of your audience.

Allis-Chalmers tells a step-by-step story in *Power from Uranium*, a 20-min color film. Exploration, mining, milling, and atomic reactor end use are all covered. Prints can be obtained from regional sales offices or *Industries Divs. Advertising Dept., Allis-Chalmers Mfg. Co., Milwaukee, Wis.*

"The best film record of volcanic action thus far produced," is the label attached by leading volcanologists to a color-sound film of the 1955 eruption of Kilauea in Hawaii, according to the Department of Interior. The film, by the *Geological Survey* with the assistance of the *Department of Agriculture Motion Picture Service*, shows at close range the entire sequence of development of volcanic vents. For the first time it was possible for earth scientists to witness the formation of a pit crater, observe active flow fronts at close range, and obtain temperature measurements on flow fronts and in lava fountains. Free circulation of film is limited to educational and other specialized groups.

Run Crane, Run, a 25-min color-sound film points up features of the newest Lorain shovel-crane, the 7-ton, ⅜-cu yd, self-propelled Lorain SP-107. Rubber-tired machine is shown as fully convertible shovel, crane, dragline, clamshell, or hoe. Contact *Thew Shovel Co., Lorain, Ohio.*

The Concept and Principles of Functional Drafting is a new sound film which seeks to demonstrate how simplified drafting makes drawings easier to read and interpret. The 20-min film enlarges on 12 fundamental principles. Available through *Gerard A. Glass, Executive Director, Industrial Education Institute, 25 Huntington Ave., Boston 16, Mass.*

Fuller Mfg. Co., Kalamazoo, Mich., offers a color-sound movie for operators of heavy-duty earthmoving and mining equipment using the 9-speed, single-stick Fuller R-1550 Road-Ranger transmission. Proper use for top performance is highlighted.

A 22-min color-sound movie called *Bonus Loads* highlights design and operating features of the Michigan line of tractor scrapers. For this on-the-job documentary contact your local Michigan distributor or write to *Clark Eqpt. Co., Construction Machinery Div., Pipestone Road, Benton Harbor, Mich.*

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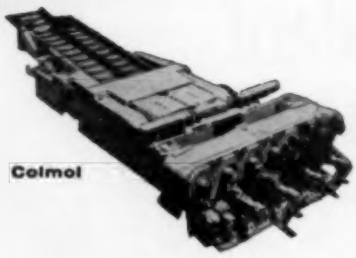
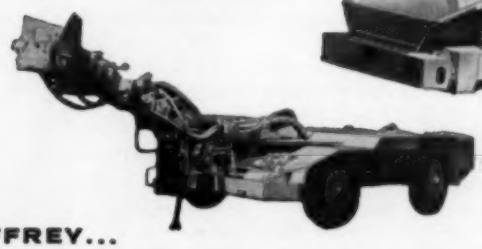
Production goes up with Jeffrey machinery in your mine. Maintenance is low. The reason . . 80 years of world-wide experience applied to the development of mining and materials-handling equipment.

Loader



Colmol

Shuttle Car



Drilling Machine

SPECIFY JEFFREY...

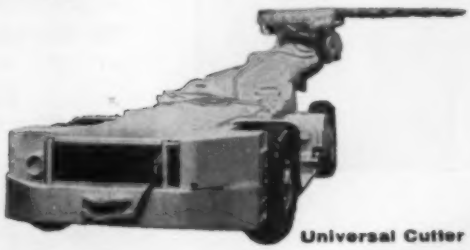
LOADERS, fast and easily maneuvered, to cut your coal production costs.

COLMOLS for high tonnage production.

SHUTTLE CARS, matched to your mining height, to insure maximum loads.

ROOF AND FACE DRILLS to increase speed and safety of these operations.

UNIVERSAL CUTTERS to handle any kind of cut, any place in the seam.



Universal Cutter

Let a Jeffrey engineer show you how to reduce costs with Jeffrey mining machinery and handling equipment. Call our nearest office. The Jeffrey Manufacturing Company, 865 North Fourth Street, Columbus 16, Ohio.

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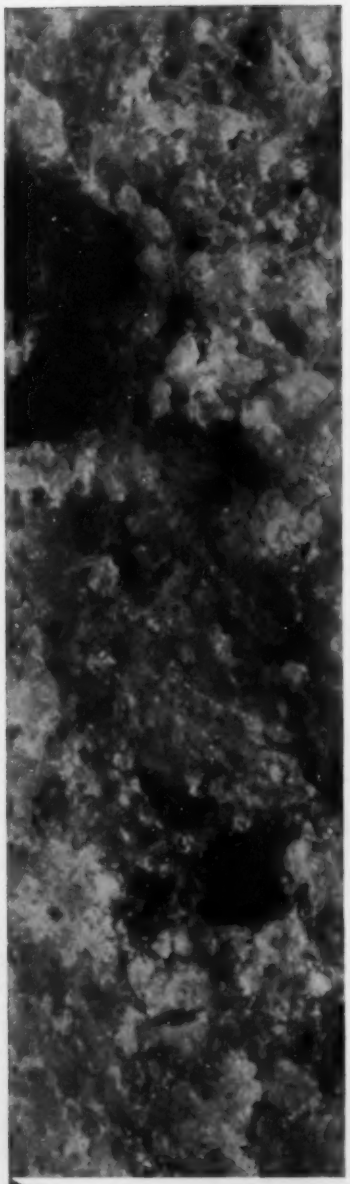
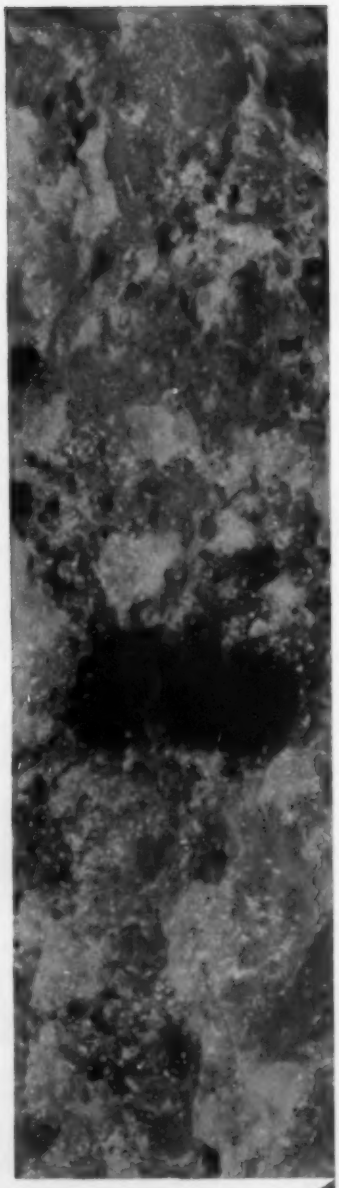


79,316 extra tons of gold ore ground with one set of Ni-Hard liners



Ni-Hard* nickel-chromium liner segments in a 7′ x 6′ overflow ball mill ground 195,765 tons of gold ore—79,316 tons more than manganese steel liners used in the same service.**

This extra tonnage reduced grinding cost per ton 45.5%!

Ni-Hard mill liner segments are available from authorized producers throughout the country. For the address of the one nearest you, write to Inco.

*Registered trademark **Plant name and details on request

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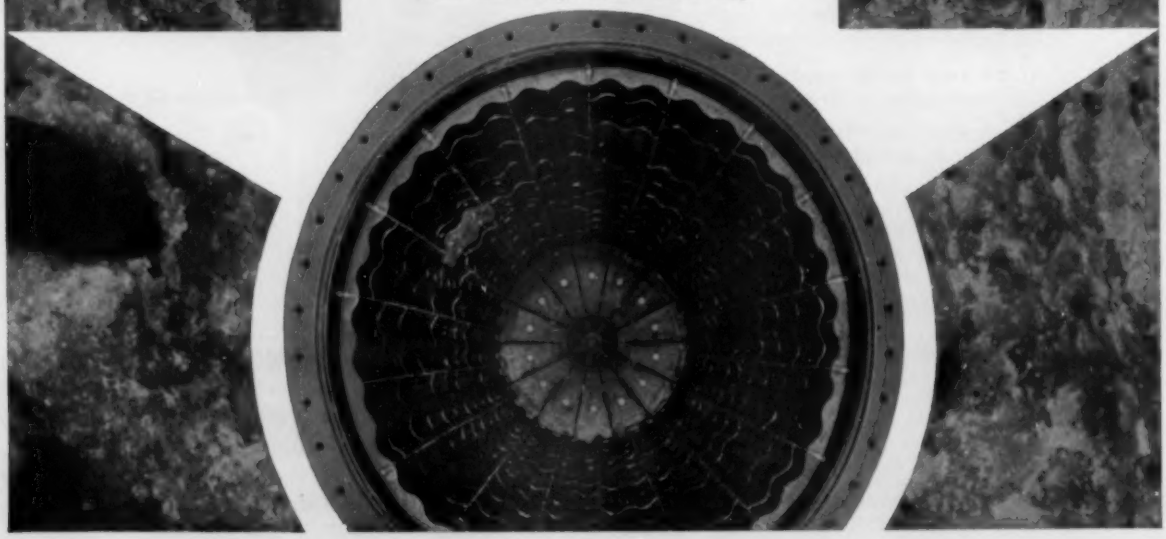
Nickel Makes Alloys Perform Better Longer



MINING engineering REPORTER

Stabilization Plans Go to Congress

A copper stockpile proposal has been newly added to Administration plans aimed at propping non-ferrous metal production. A similar stockpile measure urged by lead-zinc and aluminum producers for their metals was turned down by the Senate Interior Committee. By placing copper in this status, the red metal has been removed from original subsidy plan legislation. A separate plan being considered by the committee would provide bonuses for domestic production of beryl, chromite, and columbium-tantalum. Meanwhile, the House Interior Subcommittee has approved the authorization of a 1-year extension of Government purchases of tungsten, fluorspar, asbestos, and columbium-tantalum.

Coal Freight Tax Ended

Passage of the bill repealing the 3 pct Federal excise tax on freight transportation also has ended the 4¢-a-ton levy on coal haulage. The 4½ pct tax on pipeline transportation of oil was likewise written off. Additional help for coal producers will come through reductions in haulage rates for coal announced by a number of railroad lines.

Howe Sound, Haile Consolidate

Howe Sound Co. and Haile Mines Inc. have been consolidated into the newly-formed Howe Sound Co., a Delaware corporation. Net assets: More than $30 million. Main divisions: Mining and ore processing, manufacturing, and export-import.

PCA Chops Potash Prices

Effective July 1, prices of Potash Co. of America were reduced about 6½ to 7 pct below fiscal 1957-1958 levels. Prices were scheduled to begin at 32¢ per unit for shipments in July and August, and increase to 36½¢ per unit by January.

Building Offshore Sulfur Plant

A major step has been taken in Freeport Sulphur Co.'s $30-million project to develop the sulfur deposits of Grand Isle, seven miles off the Louisiana shore. Construction has started on a Y-shaped steel *island* that will support a gas heating plant, two drilling platforms, a heliport, and crew quarters. A third platform will be situated some distance from the main structure, which will stretch for almost a mile. Employing the Frasch process, the plant will use 13 million cu ft of gas to heat 5 million gal of seawater daily. A total of 250 men will work five-day-on, five-day-off shifts, and transfer to shore via company helicopters. Production slate reads 1960.

Venezuelan Wilds Go Industrial

By autumn, an industrial complex, incorporating a steel mill of eventual 1.2-million ton annual capacity and a $40-million dam and hydroelectric plant, will have begun to emerge from a legendary Venezuelan wilderness. Basis: huge reserves of high grade iron. The

big works in a remote southeastern area is to cost a total of some $400 million. Bethlehem Steel Co. and U. S. Steel's Orinoco Mining Co. are already working rich deposits, Bethlehem at El Pao and Orinoco at Cerro Bolivar, both near the Orinoco and Caroni Rivers. A third big mine is held by a Venezuelan firm.

Possible Extension of DMEA

The Defense Minerals Exploration Act may become a permanent program entirely under the jurisdiction of the Department of the Interior. Legislation for the move has been approved by the Senate Interior Minerals Subcommittee and would save the program from scheduled expiration on June 30. DMEA has previously been under authority of the Office of Defense Mobilization, although administered by the Interior Department.

Thorium Plant for Rio Tinto Dow

Canada's first thorium plant will be constructed, at a cost of about $1 million, by Rio Tinto Dow Ltd. Production will total 100 to 200 tons of salts annually—about the amount now produced by the entire world —and operation is scheduled to begin by January 1959. Site is the Algom Quirke holding at Blind River, Ont.

Chile Wants USSR As Copper Customer

Chile has requested a change in an agreement with the U. S. banning Chilean exports of copper to Russia or satellite nations. Citing harm to the Chilean economy through the restriction, the country's Copper Department said world conditions have changed and certain, formerly strategic, products have changed categories.

Disallow Gold Mine Claims on Wartime Closures

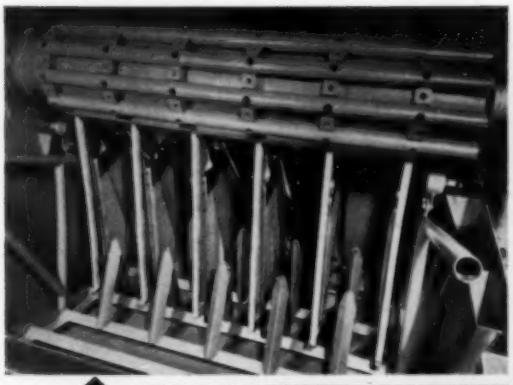
Supreme Court review of compensation claims filed by gold mining companies forced to close operations during World War II ended with a 7 to 2 decision against Government compensation. Gold mines were closed by Government order on October 8, 1942, in hope that miners would switch to essential work in copper operations.

Electrostatic Separation for Taconites?

Testing of an electrostatic separating device developed by the Quaker Oats Co. will soon be begun by the Dings Magnetic Separator Co. to determine its use in non-magnetic beneficiation of taconite. Carpco Mfg. Co. had already developed units employing electrostatic fields for iron ore separation. Fresh field for use of electrostatic separators may well be the iron ore discoveries in the Labrador Trough.

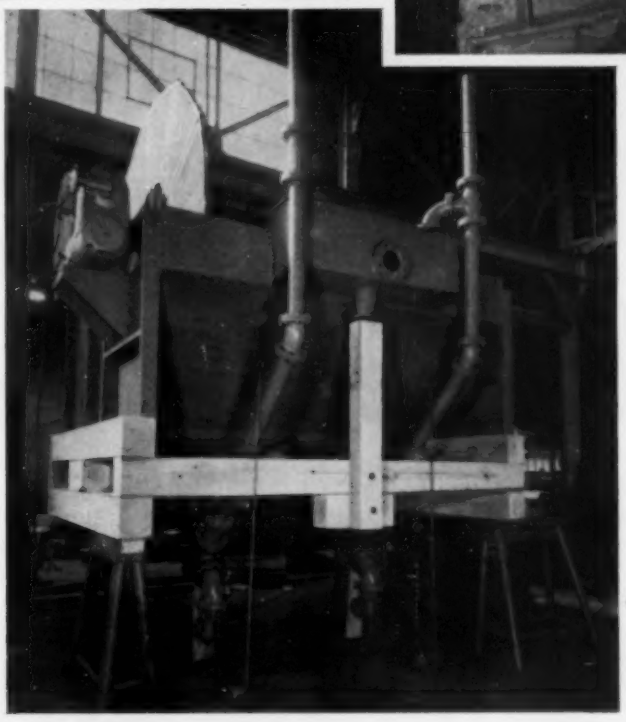
Non-Nuclear Uranium Uses Approved

More freedom for uranium producers: AEC has removed the restriction on non-nuclear uses of uranium, permitting private sales to ceramic and glass makers and photographic suppliers. Depleted uranium—from which a portion of the natural content of fissionable U-235 has been removed—will also be available from the AEC. The commission notes that pre-war sales of uranium for industrial applications amounted to about 200 tons yearly.



SWING TYPE AGITATOR, installed in filter tank, is shown in this close-up photo. Torsion bearings are at left and right, just under the main shaft.

TYPICAL INSTALLATION of American Disc Type Filter with air lift agitation provides efficient agitation of non-foaming slurries.



AIR LIFT AGITATION EQUIPMENT, consisting of valves and piping, is shown in this factory floor photo of partially assembled filter. No moving parts—pressure and quantity of air controls agitation.

Now...from DORR-OLIVER

3 methods of agitation on AMERICAN FILTER

Dorr-Oliver's continuing search for improved techniques in wet processing has now resulted in three entirely different methods for slurry agitation on the American Disc Type Filter.

1. **AIR LIFT AGITATION**—means no moving or mechanical parts, the degree of agitation being controlled by the quantity and pressure of air injected. The result, on most non-foaming slurries where the introduction of air is not objectionable, is a homogeneous slurry and negligible maintenance.

2. **SWING TYPE AGITATION**—completely eliminates lubricating and stuffing box problems. This is accomplished by torsion bearings which incorporate a special rubber compound bonded to the agitator shaft to accommodate agitator assembly oscillation. This method is ideally suited for easily foamed or oxidizable slurries.

3. **PADDLE TYPE AGITATION**—with controlled variable speed drive, is also excellent for handling easily foamed or oxidizable material.

For more complete information, just drop a line to Dorr-Oliver Incorporated, Stamford, Connecticut.

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MINING engineering NEWS

Aluminum—Cold War Casualty?

"Soviet aluminum, offered sporadically in the world market at unrealistic, throat-cutting prices, has helped to depress the American market. Picking and choosing the most strategic areas in which to dump their metal, the Russians have begun a systematic campaign against the aluminum industry," charges a leading U. S. producer of the light metal. Here is the story, with background on the growth of the Russian industry.

A CONCLAVE of spokesmen for seven U. S. aluminum companies met with officials of the State Department recently to discuss a fast-growing problem in the light metal industry, namely, the predatory attack by Russia and its satellites on world aluminum markets by selling the metal at cut-throat prices.

The State Department has described the Russian action as economic warfare. Russian sources describe the sales as a mere outgrowth of a surplus material situation despite a recent report that Soviet bloc nations have agreed to integrate their economies and to pursue joint economic policies in a drive against the Free World. Whatever the reason for the Russian sales, the impact of their low-price offerings is strongly felt.

It is expected that the USSR may shortly supplant Canada as the world's second biggest aluminum producer and the erratic but increasing influx of Russian metal has lopped disturbing chunks out of Western producers' sales. Aluminum Co. of Canada, in its sales to Britain, finds Russian competition quoting prices 11 pct lower than its own. And the two-cent price cut initiated by Canada's Aluminium Ltd. in March was laid mainly to sales by the USSR. This slash was followed by still sharper undercutting by the Soviets, which are presently selling their wares in Europe at from one to two cents a pound below Western quotations.

U. S. producers want protection from what they claim is unfair competition, politically planned and thoroughly subsidized. When the State Department conferred with the producer group mentioned earlier, a five-point program was outlined by the manufacturers as a possible means of alleviating the situation. Suggested aids included:

- Channeling world surpluses of aluminum to areas where the metal is most needed.
- Collaboration between principal allies of the Free World to market the metal in ways that would prevent economic injuries.
- Limitations on imports in times of U. S. surpluses to offset the foreign advantage of low wage costs.
- Study of possible anti-dumping legislation.
- Complete collaboration between Government and industry in combatting the Soviet economic offensive.

Reynolds Metals Co. recently surveyed available information and pieced together a story on the rise of the Russian aluminum industry. This is the story which emerged.

Russia's Aluminum Industry began in 1932 when, with the help of French technicians, the first Russian aluminum plant was built at Volkhov, about 80 miles east of Leningrad. Drawing power from the Zvanka hydro-electric plant, it began production with 1100 tons per year. By 1939, it was producing 88,000 tons of alumina and 22,000 tons of aluminum annually.

Between 1932 and the outbreak of World War II Soviet aluminum production jumped from zero to an estimated 55,000 tons annually. A plant in the Ukraine—Zaporozhye—produced 32,000 tons a year. A third, producing alumina and aluminum, was erected at Kandalaksha in Karelia.

These three plants suffered severe damage during the German invasion. But the Russians managed to move much of the equipment to new plants in the Urals and Siberia: Kamensk-Uralsky, Krasno-Turinsk and Stalinsk, the latter near Lake Baikal. Annual aluminum production, at 61,000 tons in 1942, went up to 78,000 tons in 1944.

At the close of World War II the Soviets systematically stripped the aluminum industries of East Germany, Hungary and Manchuria and installed the equipment in Russian plants. By the end of 1947, Soviet production reached an estimated 99,000 tons.

Soviet desire for great air power led the Kremlin to pour money and manpower into the Soviet aluminum industry. To build a strong air force, Russia concentrated on construction of new plants as well as enlargement of existing facilities. By 1957, Russian production—combined with that of her satellite nations—attained an estimated 710,000 tons annually. The fastest growing aluminum producer in the world, the Soviet bloc now makes 22 pct of the world's aluminum.

How many alumina and reduction plants has Russia today? In addition to the six mentioned earlier —Volkhov, Zaporozhye, Kandalasksha, Kamensk-Uralsky, Krasno-Turinsk and Stalinsk—there are believed to be new plants in production or under construction at Sumgait, Yerevan (Armenia), Irkutsk and Krasnoyarsk (Siberia), and Stalingrad, Achinsk, Nadvoystsy and Tikhivin. These are in addition to plants operating in Hungary, Poland, China, East Germany, Czechoslovakia, North Korea, and Rumania.

The total present capacity of the reduction plants in the Soviet satellites is an estimated 286,000 tons annually. Informed observers predict that the Soviet bloc will produce 1.43 million tons of aluminum annually by 1961.

Russian Aluminum Ores: Russia claims to possess extensive deposits of aluminum ore but the size and quality of its reserves have not been made public. Rich bauxite deposits in Hungary are available to Russia and, from available information, it would seem that considerable bauxite exists in the Soviet itself. The Russians also use nepheline syenite and alunite as sources of aluminum to a small degree although their use is not believed as economic as the use of bauxite. Since Russia's nepheline syenite exists in tremendous quantities it is not probable that the USSR will exhaust its raw materials for producing aluminum, even if its bauxite supplies dried up.

In spite of the great upsurge in aluminum production in the Soviet and its satellites, the Russian bloc imported large amounts of the light metal from the West until about three years ago. Suddenly, in 1955, Russian aluminum began to appear in the international market in large amounts. Last year the Soviet fed 37,000 tons of aluminum into the trading arteries of the Free World.

How did this come about? Why, after all these years, did Russia suddenly begin spewing forth the aluminum she had so carefully kept for herself since 1932?

The answer lies in something American producers also experienced. With the advent of the missile age, military requirements—for aircraft, primarily—dropped appreciably. Guided missiles and supersonic airplanes consume far less light metal than the pre-missile air power required. In America, where over 90 pct of aluminum production goes to civilian consumption, the change in military requirements did not have the impact that it had in Russia. There, with virtually all aluminum going to military use, the change in requirements created a great surplus of aluminum.

Significantly, the Russians did not to our knowledge cut back production to adjust to the new situation. They continued producing and expanding. Aluminum production, used until 1955 to make weapons, now itself became a weapon.

From Importer to Exporter

In the past three years more than 80,000 tons of Russian aluminum has hit the world market. There is a two-part pattern: It appears in large quantities sporadically. It is priced to undersell all existing suppliers.

Since the aluminum industry in Russia is nothing but an arm of government, the price for which it sells bears no relation to the cost of producing it. Slave labor or low-wage workers, state-owned bauxite mines, state-owned transportation, state-owned plants and equipment . . . no interest, no taxes, no accounting. No one knows exactly how much it costs the Russians to produce a pound of aluminum. We know only that they have been selling it at whatever price will beat the free world producers.

To date, the Russians have sold mainly in Europe, also in India and Argentina. But the fortunes of the American aluminum market are tied to the conditions of the world market. The impact of Soviet aluminum in these areas has been felt here.

This has hurt. There are indications that, unless means are forthcoming to combat the Soviet actions, we will be hurt more.

Loading aluminum pigs on a railway flatcar at a Russian works in the Kemerovo region of Siberia.

MINING engineering **TRENDS**

Weevil Beware

King cotton's market skirmishes with the artificial wonder fibers show the old textile staple to be a still-strong adversary. And federal researchers have now discovered that the ancient fiber has new versatility when it is coated with any of several metallic hydroxides. For example, a dousing in certain elemental compounds increases cotton's mildew and rot resistance. It has been found that cobalt processing steps up the fiber's water-shedding ability and that cotton steeped in hydroxides of aluminum and magnesium is better able to resist flame.

Lighter Blocks for Lighter Automobiles

Under headlines in the trade papers such as "Experimental Aluminum Motors Seen by GM as Break-through" and "GM Engineers 'Optimistic' of Future for Aluminum Motor" the auto industry revealed new progress in making practical and economic all-aluminum engine blocks. While many questions remain to be answered before the showroom sees the results, several engines have been road tested which rely on neither an iron or steel sleeve nor on a hard plating of the cylinder wall the solution being a wear resistant aluminum alloy reportedly neither new nor expensive.

On another front the stainless steel producers had almost delivered a knock-out to the hopes of titanium in the rocket and jet aircraft field. However Crucible Steel has now developed a new beta titanium alloy claimed to have greatest strength to weight ratio of any commercially available structural material.

New President, Old Problem

Mexico's newly elected President Lopez Mateos has been variously described as "middle of the roader" and "friend of U.S. capital" and was actually the Labor Secretary under President Cortines. He was elected by PRI (Partido Revolucionario Institucional) which has brought stability to Mexican politics, while itself growing more conservative, or at least becoming less "left".

As President he will find many bright spots in the economy, but by all reports the mineral industry will not be one of them. Sulfur is an exception. Petroleum production and distribution (a government monopoly) has apparently shown progress in recent years but results still fall short of the governments objectives of self-sufficiency *and* adequacy.

Under present taxation mining is profitable for few firms in Mexico. Close observers suggest caution in any expectation that these taxes will be changed rapidly, yet, capital expansion and new investment in mining is needed. The capital flow from the U.S. will depend on either lowering of taxes, reported unpalatable politically, or on finding a face-saving formula for elimination of the effect of these taxes.

One out remains, if taxes on mining do not come down and capital does not come in. After the Nixon tour of South America, Mexico may count on a friendly attitude in Washington toward government loans where private capital fears to tread. At any rate U.S. mining firms will be watching closely.

How Much Iron Ore in 1975?

Despite a recession-influenced steel rate in the neighborhood of 50 pct of capacity, despite a proven process for taconite treatment, despite large reported reserves in Venezuela and in the IOCC area in Canada, despite all these factors an intense hunt for iron ore reserves continues. Why?

Estimates vary, but none is lower than 170 million ingot tons of steel production capacity in the U. S. in 1975. Translated into ore requirements, estimates approach 200 million tons as the yearly ore consumption only 16 years from now. No present prediction or estimate of output from domestic sources suggests that they will provide more than 100 million tons. Where will the rest come from?

Ten years ago the answer would probably have been: South America. Five years ago the answer would have included Quebec-Labrador as a second great soruce of supply. Tomorrow the balance may have shifted still further to northern, not southern sources. Among the factors are apparently these (aside from the purely technical ones): rising South American labor costs, political considerations, taxation problems, and not least—vulnerability of ocean shipping in wartime.

Writing in *Skilling's Mining Review* this spring Verne D. Johnston forecast that about 75 million tons would come from Canada. In a recent issue (*ME* June page 680), P. E. Cavanagh suggested one-half to two-thirds of future U.S. imports would come from Canada, while indicating total U.S. import needs would be a conservative 60 million tons.

These figures, and other estimates, range from 30 to as much as 75 million tons of Canadian iron ore going into U.S. blast furnaces less than two decades hence. What are the possibilities of this much ore being produced in the North?

Latest reports of projects in the Mt. Wright-Wabush Lake area indicate a possible 25 to 40 million tons of concentrate from there. IOCC adds another 20 million tons from farther north, to the west Steep Rock adds another 20 million tons. Lesser production, including Inco (see page 864, this issue), Marmora, and Algoma would account for another 5 or 10 million tons. Total, perhaps 80 million tons. More projects can be expected.

Against this already announced potential, one prediction indicates 1975 Canadian consumption of 15 million tons, possible European imports of 15 million tons, leaving a net available tonnage of about 50 million tons.

CYANAMID

REAGENT NEWS

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Three Typical Examples of Effective Copper Collection with Cyanamid Flotation Reagents

Proven most efficient and economic, these Cyanamid flotation reagent combinations have stood the test of time at three typical copper flotation operations.

MINE A

Using SODIUM AEROFLOAT® Promoter since 1948, started up on AEROFLOAT® 208 Promoter in 1941 and now treats 51,000 tpd of chalcocite ore with some pyrite and molybdenite (heads 0.9% Cu). Grind is 8.5% on 65 mesh with middlings reground. SODIUM AEROFLOAT dosage is 0.023 lb/ton, frother a mixture of cresylic acid (0.06 lb/ton) and fuel oil (0.003 lb/ton). Lime at 4 lb/ton helps depress pyrite. MoS_2 is also recovered using sodium ferrocyanide, together with sodium cyanide, as copper depressants. Concentrate runs 25% Cu, tails 0.18% Cu (with 0.12% oxide). Moly concentrate runs 89% MoS_2 and under 0.5% Cu.

MINE B

Has been using Cyanamid Reagents exclusively since start-up in 1955. It mills 12,000 tpd of chalcopyrite ore (heads 0.9% Cu) containing some pyrite and molybdenite. Collector in preliminary copper circuit (making a high-grade concentrate) is AEROFLOAT 238 Promoter at 0.016 lb/ton with mixture of AEROFROTH® 70 and 65 Frothers (4 to 1 ratio with F-70 at 0.03 lb/ton). Bulk copper-pyrite float follows utilizing 0.015 lb/ton AERO® Xanthate 301 with small amount AEROFROTH 65-70 combination. Chalcopyrite is selectively floated from pyrite in bulk concentrates with 8 lb/ton lime and 0.05 lb/ton AERO® Brand Cyanide, no additional promoter. Copper concentrate runs approximately 26% with tailings 0.08% Cu. Moly recovery not attempted at present time.

MINE C

Our first liquid AEROFLOAT customer—has been using liquid AEROFLOAT Promoters for over 30 years. Mill tonnage is 6,500-6,800 tpd copper-bearing magnetite ore with 3,300 to 3,600 tons going to chalcopyrite and pyrite flotation. Copper-magnetite middling product is floated from magnetite concentrate with approximately 0.16 lb/ton AEROFLOAT 33 Promoter. Tailings from magnetite recovery and the copper-magnetite middlings are reground and floated using a combination of AEROFLOAT 15 (0.083 lb/ton) and AERO Xanthate 301 (0.003 lb/ton) together with 0.01 lb/ton NaCN, 1.5 lb/ton lime as pyrite depressants to make final copper concentrate running 25.5% Cu. Pyrite is then floated with AERO Xanthates 303 and 343 (approximately 0.04-0.06 lb/ton each) and 0.03 lb/ton pine oil. Pyrite concentrate runs approximately 49% S.

AEROFLOAT Promoters, AERO Xanthates and AERO Promoter 404, proven as copper promoters over many years, are still the preferred collectors in today's copper milling operations. A review of your flotation practice and reagent combinations could bring profitable rewards. A Cyanamid Field Engineer will be glad to work with you.

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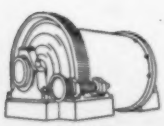
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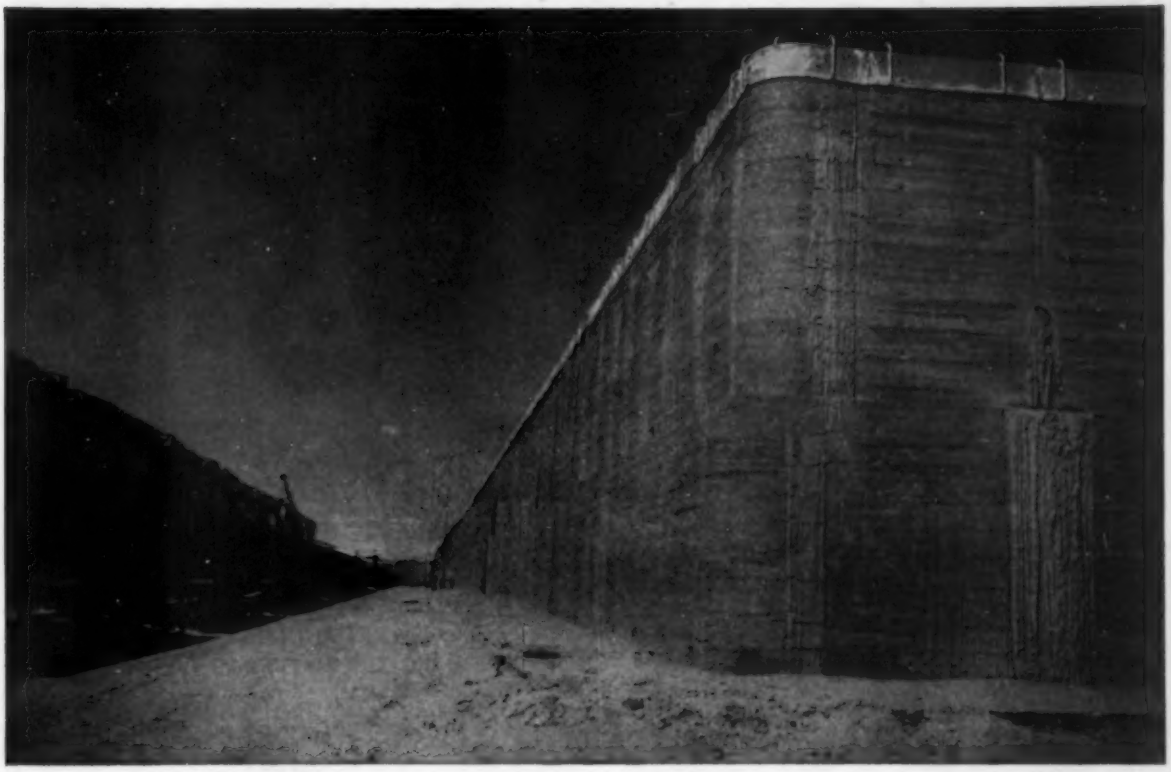

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...a continuing company policy established years ago

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Journal of Metals—monthly

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Transactions of The Metallurgical Society—bimonthly

MINING engineering

DRIFT

Programs, Postage, and Marketing

• One of the operating advantages developing from the long range reorganization of the Institute has been flexibility in programming. The Annual Meeting needs of each of the three groups are apparently quite different—and the Three-Society arrangement means that SME program personnel are now free to shape a pattern of sessions to suit their audience (and the metallurgists and petroleum men are no doubt doing likewise).

The miners have long criticized excessive programming and overlapping session schedules at the Annual Meeting. Among the answers to this problem have been: Fewer sessions, more joint sessions, and better session topic selection. The results have been fewer conflicts and promotion of papers and topics that provide grounds of common interest for different groups.

Bob Grogan, SME Program Chairman, expressed some of these ideas in a letter to Society program personnel; R. J. Lacy echoed them in his general instructions to the M&E Program Committee; and similar policies underlie the planning of the other divisions. Much progress toward a better Annual Meeting for mining engineers was made both at New Orleans in '57 and New York in '58, and the future—San Francisco in '59—is in good hands.

• In recent weeks postage stamps issued by the U. S., Switzerland, and Sweden have commemorated items on the fringes of the mining field. Our newest stamp celebrates IGY with a vivid black and red representation of sun spot flare-ups; while Switzerland is issuing a series of stamps featuring minerals, rocks, and fossils; and Sweden is honoring the hundredth anniversary of the Bessemer Process in that country (we celebrated the hundredth anniversary two years ago in this country).

A quick check of U. S. commemorative issues indicates that poultry, gymnastics, girl scouts and railroads have all been honored but nary a one on mining, although foreign stamps have honored the industry. The 50th Anniversary of AISI and 100th Anniversary of ASCE were honored however. It seems about time this omission was corrected and our candidates for a new commemorative are the great Utah Copper pit at Bingham, the Hull-Rust pit in Minnesota, or perhaps a continuous coal mining machine.

Postage stamps are a tremendous way to reach a broad public with the importance of mining, but not the only way. In recent weeks several hundred thousand people passing through Grand Central Station had a chance to see and hear about ASARCO's complex operations which bring a variety of base metal and chemical products to industry, and ultimately to the public. The exhibit, one of a series on different companies and industries, was in a permanent site on the station concourse occupied by the security firm Merrill, Lynch, Pierce, Fenner & Smith. The nearest to this excellent exhibit that we know of was the presentation on iron ore put on at the Minnesota State Fair in recent years.

Comment: There are a lot of other fairs, and airport terminals, and railroad stations where the mining story could reach the public.

• A couple of months ago we commented on the need for aggressive marketing if metals wish to retain their relative competitive position. It is pleasant to cite two steps in the right direction: First, *The Zinc Spotlight*, a new quarterly newsletter from the American Zinc Institute "designed to keep readers abreast of new product research . . . design developments, etc." Second, the direction of the established periodical of the Lead Industries Assn., *Lead*, in highlighting "exciting" new uses for the metal. Probably the most important point is not the scope of the developments, but rather the publicity—reflecting awareness of market development needs by the industries.

ONLY CATERPILLAR GIVES YOU THE OIL

Here is what you should know about its money-saving and operating advantages

How much better is the exclusive Caterpillar oil clutch than the ordinary clutch? It can be summed up in this short statement:

When the Caterpillar oil clutch is ready for *adjustment*, the ordinary clutch is ready for *replacement*. Experience in the field proves it.

In the years since 1954, when Caterpillar introduced this remarkable advance in earthmover power trains, owners all over the country have reported thousands of hours of oil clutch operation free of adjustment or repair.

Typical of these reports is this one from Myron Omernik, land improvement contractor of Custer, Wis.: "Our D7 has operated 5,100 hours without any oil clutch repairs or adjustment."

This performance record means two clear-cut money-saving advantages:

1. Virtual elimination of down time caused by clutch failure.

2. Greatly reduced repair costs.

But in addition to its economy features, the oil clutch also provides superior operation. Here is why:

1. A hydraulic booster on the D9 and D8, operated by clutch oil pump pressure, takes the effort out of clutch operation but retains clutch "feel."

2. Clutch "fade" because of overheating is practically eliminated. The oil in which the clutch parts run is pumped directly from the crankcase. This means the clutch temperature never rises above engine temperature.

3. A clutch brake helps match clutch and transmission speeds—making shifting easier.

Here, in brief, is how the oil clutch works:

Three metallic-faced plates are separated by oil films at all times except for the last revolution or two as the clutch is engaged. Oil enters the inner diameters of the clutch plates and circulates between them by means of grooves in the clutch facings, carrying away heat and reducing wear. All clutch parts are constantly running in oil.

The exclusive Caterpillar oil clutch is not an "extra"—it is *standard equipment* on the D9, D8, D7 and D6 Tractors, all Traxcavators, on the No. 12 Motor Grader and on the MD6 and MD7 Pipelayers. Yet it is an "extra" in *value* that is unmatched in the industry.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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Clutch brake helps match clutch and transmission speeds—makes shifting easier.

Removable coupling allows clutch to be removed without disturbing engine or transmission.

Double clutch plates are metallic-faced for heavy-duty torque transmission.

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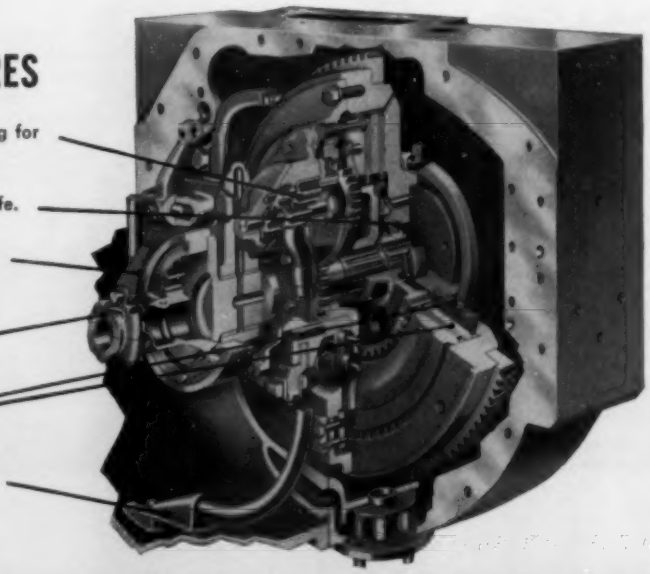

CLUTCH

CAT D9 TRACTOR: "We have operated this Cat D9 Tractor for 4,000 hours in the toughest kind of work without any repairs to the oil clutch," says Frank Hill of the Silva & Hill Construction Co., Los Angeles, California. "I just wouldn't consider buying a tractor without it now."

CAT NO. 955 TRAXCAVATOR: "In over 4,000 hours on our two hard-working No. 955 Traxcavators, we have made only one simple adjustment on an oil clutch and that took only about a half hour. It's much simpler than the old friction-type clutch," says M. J. Lutz of Bethel Park, Pennsylvania.

OWNERS REPORT TROUBLE-FREE OPERATION

CAT NO. 12 MOTOR GRADER: "Our No. 12 is starting its third season without interruption due to clutch trouble." With only one clutch adjustment in over 2,000 hours, Francis Bloomer, President of the John F. Bloomer Co., Appleton, Wisconsin, says, "We like the No. 12 with the oil clutch." This company, with 35 years of road construction work, owns a fleet of Cat-built equipment consisting of No. 12s, D9, D8s, DW21s.

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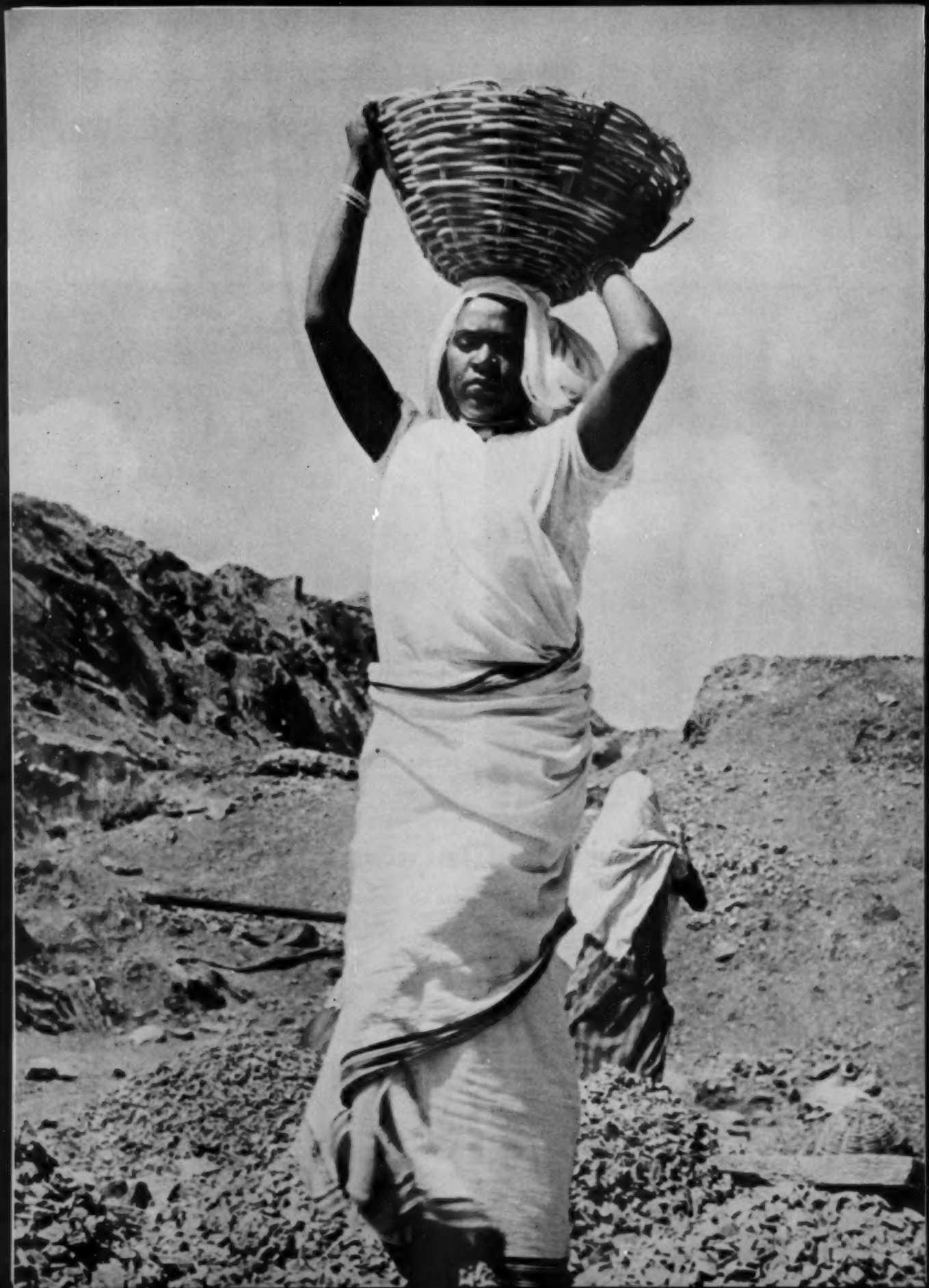

"The primary objective of industrialization should be a higher standard of living for the people who are served by it."

Problems in Mechanization in Primitive Countries

by James V. Thompson

ENGINEERS from industrialized countries are frequently called upon to examine mining operations in primitive areas and make recommendations regarding mechanization and modernization. They often set forth with self-confidence, knowing full well that all that is needed is their experience and several shiploads of mining machinery, and at times they mentally provide the answers before the problems have been clearly stated. In primitive areas it is absolutely essential that the examining engineer spend enough time at the site to acquire a thorough understanding of what is being done now and why it is done the way it is.

The objective here is to state in simple terms some of the problems that may be encountered, inasmuch as solutions, if they can be found at all, will differ with each experience.

A specific case will illustrate the problem. Kaiser Engineers Div. of Henry J. Kaiser Co. was asked to examine an open pit limestone quarrying operation in India and recommend ways of greatly expanding the output and lowering cost of operation. To introduce the situation a description of this operation will be helpful.

Case History

The properties are located at Birmitrapur, State of Orissa, about 230 miles west of Calcutta, and are generally accessible only by railroad and airplane. The climate is tropical to subtropical, with annual rainfall of about 65 in. The quarries are a private enterprise operated by a British firm that is now a "rupee company." The limestone quarries are operated primarily to produce flux stone for the steel industry of eastern India, but some of the stone is consumed in local shaft-type lime kilns. The steel industry of India is undergoing great expansion, both in the form of private enterprise and in government-sponsored projects.

Limestone Formation: The limestone formation is a dense, fine-grained, metamorphosed, Pre-Cambrian limestone, dipping 50° to 70°. The workable quarries are found in the outcrop, which forms a ridge above the surrounding area. The structure varies widely in insoluble content, which is one measure of its usability to the steel industry. Alternate streaks of high and low insoluble stone occur together, and bands as wide as several feet, or as narrow as a few inches, are found containing as little as 5 pct insoluble and as high as 30 pct.

Extent of Quarries: The quarries, which are quite extensive—4.5 miles along the strike and some 0.5 miles across—are worked from about 15 pit areas. The various pits are served by numerous railroad sidings branching off the terminus of a 16-mile branch line of the main east-west Indian railroad system.

Grade of Stone: Several grades of limestone are produced for blast furnace flux, open hearth flux, and rotary and shaft-type kilns.

Average stone shipped from the property contains about 7 pct insoluble (combined silica and alumina). To maintain this 7-pct grade it is necessary to reject as waste about one third of the stone containing about 20 pct insoluble. At present the quarries are shipping approximately 2800 tpd of all grades of stone. When they were first opened, specifications for some flux stone required an insoluble content as low as 4 pct, but over the years this has gradually increased, and some shipments are now as high as 9 pct. Current specifications for open hearth grade generally require a silica plus alumina content no greater than 5 pct; for blast furnace stone it should not exceed 10 pct. These specifications represent a gradual compromise, as they are higher than the steel mill operators would like.

Method of Quarrying: Primary drilling is done with wagon drills using jointed steel. Benches are drilled from depths of 25 to 70 ft and holes are loaded with 80 pct nitroglycerin dynamite. Blasting breaks 6 to 7 tons of stone per pound of explosive and considerable secondary drilling and blasting is needed. The quarries are supplied with compressed air from a variety of diesel and steam compressors.

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After the stone is blasted both male and female laborers move into the blast face and reduce the stone with sledge hammers to approximately 4 in. This hand reduction is integrated with hand-sorting and hand-cobbing.

Loading and Transportation: The current ratio is one of waste to two of dispatched stone. The alternating occurrence of good and bad stone at various widths—a few inches to several feet—requires highly selective mining, hand-cobbing, and sorting of material to maintain grade. The *good* and *bad* stone are then loaded separately into wicker baskets holding 50 to 70 lb. Men at the face hoist the baskets onto the top of a woman's head and she carries them to the nearest narrow-gage hand-trammed car.

After the cars are loaded with good or bad stone they are trammed, generally by hand, to a waste disposal point or a *good* stone bin at bench level. Some of the quarries are equipped with incline hoists that raise the loaded cars to a disposal point. The good stone is generally transferred from level to level by being withdrawn from one bin and trammed to the edge of a bench and dumped into another stone bin. This process is repeated several times, and finally the narrow-gage cars are trammed onto a trestle straddling a cut that is actually the roadbed for the broad-gage railroad.

Broad-gage cars spotted under the trestle receive the contents of the narrow-gage cars. The various benches are not interconnected from level to level except by incline hoists, and even these are usually installed only in pits below the level of the broad-gage tracks.

Output per manshift is 1.43 tons for people actually breaking, sorting, and tramming stone—somewhat more than half the labor force. This calculation does not include those engaged in development, maintenance, and other types of labor.

Size and quality are controlled in the pit by company representatives, frequently women. Inspectors use steel rings to test the size of the stone in the cars on a random basis.

The railroad serving the quarries is extra broad gage, 5-ft, 6-in., and all equipment is of European type. Steam locomotives are used which burn Indian coal. While the railroad appears to be adequately supplied with rolling stock, it also appears to have difficulty in spotting cars at the numerous sidings and withdrawing loaded cars in a manner that can be coordinated with quarry operation. By U. S. standards the demurrage allowance on rolling stock is fantastically low, and only 5 hr is allowed. Future expansion plans for these quarries depend largely on the railroad's capacity to handle the traffic.

Production Costs: Costs reported here have been converted to U. S. dollars for comparison with similar operations in the U. S. Overall cost per ton of stone quarried is 88¢, or $1.32 per long ton of stone dispatched. Labor constitutes 64.1 pct of this total cost; welfare, 5.5 pct; expendable supplies, 19.0 pct; miscellaneous, 2.5 pct; depreciation, 3.8 pct; and administration, 5.1 pct. The operation is highly efficient and well managed. Considering the hand picking involved, a cost of $1.32 per long ton would be difficult to reduce in any country.

Labor: The average daily labor force comprises some 5400 people, about 55 pct men and 45 pct women. Men and women usually work in family groups in the same general area in the quarries. About 3000 of these people are actually employed in breaking stone. This figure is based on an average daily production of 4320 tons of broken stone, of which 2880 tons are sorted by hand and shipped to consumers. The remaining employes comprise the maintenance, clean-up, development, office and welfare personnel. The principal development involves removal of overburden and wide hanging wall waste areas by hand methods.

The laborers, for the most part, are natives of the immediate vicinity. The health of the working force is fair to good and there are no occupational diseases among the quarry workers. The company provides a number of welfare facilities such as canteens, hospitals, dispensaries, and schools. Literacy among the native working force, if defined as those who can read and write Hindi and do simple calculations, is probably 40 pct. About 20 pct can read and write English.

Women workers are of particular interest, and it is to be noted that they receive little special consideration regarding their assigned tasks in the quarries. Women with very young children are allowed an extra 20-min morning and afternoon recess to visit the nearby company-operated child welfare centers. Medical care is free and hospitals are provided within the company areas.

Welfare and Workmen's Compensation: The company meets Workmen's Compensation laws by setting aside about 1½¢ (U.S.) per ton of production. Older workers are provided for by a pension system, which pays in one lump sum the amount of two weeks' pay for each year of service.

Housing is rent-free but extremely primitive by some standards. The company is required to provide adequate warehousing and distribution centers for laborers to buy rice, which is sold for an unrealistically low amount based on prices existing some years ago.

Labor charges are distributed about equally between accounts of the company and the boss contractors. The contractors receive the money for contract work and in turn pay the contract labor, but the company is wholly responsible for all welfare provisions, including those of the contract labor force.

Absenteeism: The work week is six days long, 8 hr per day, with 2 hr for lunch. Time and a half is paid for more than 8 hr in any one day, but there is no overtime on the basis of a minimum work week. Approximately 60 pct of the overall absentee rate is attributable to men and 40 pct to women. Apparently workers enjoy their week-ends to the fullest, because considerable absenteeism occurs Monday mornings. There are also seasonal variations in the work force caused by agricultural requirements of the surrounding areas, as many workers—or their parents and relatives—own small plots of ground. Production drops off and absenteeism increases during periods of heavy rain. But on a basis of final severances, annual turnover is low—3 to 3.5 pct.

Pay Incentives: Average pay is 33½¢ per day for men, 31¢ for women (1957). Three incentive pay systems are in force, the first of which is designed to reduce absenteeism. When a laborer has attained an unbroken 22 days of work in any calendar month he or she qualifies for an extra two-days' pay. The second system is an incentive bonus, paid to production laborers for maintaining an increase per manshift for one calendar month. The third system, a form of profit-sharing applying to all classes of labor, is also intended to reduce absenteeism, since

only those employes who have completed 235 working days per year will qualify for 15 days' extra pay.

Labor Union: The local labor union is affiliated with the Indian National Trades Union Congress, a group associated with the Congress Party, which for all practical purposes has been the Government in India since Independence. The union is not particularly aggressive, mainly because its policies have to follow the dictates of the Government, and the Government is dedicated to high productivity and ultimate industrialization. It requires that within the union there be a "Workers' Committee," equally made up of labor and management representatives, whose duties are to arbitrate labor disputes of a local nature. Requirements for union membership closely parallel those of the U. S.

Safety Hazards: The safety record is not too good. Two types of accidents are recognized; minor accidents are defined as causing fewer than 21 working days lost time and major accidents more than 21 working days. Because of the method of keeping accident records it is difficult to compare accident records with those of similar U. S. operations, but apparently these quarries have about ten times the accident frequency of U. S. operations of this type. Among minor accidents 80 pct are lacerations and crushed feet and fingers. Accidents with small pit cars account for 10 pct; tripping and stumbling for 5 pct. About 5 pct are eye injuries from flying rock, as workers do not wear goggles. (It is said that goggles in a hot climate would be intolerable. But very effective, cool eye protection can be made with screen wire.)

Obviously, many of the injuries to feet and legs could be prevented if laborers wore shoes and some type of shin protection. But this is suggesting measures that are at present probably beyond the country's economy, to say nothing of the willingness of the laborers to cooperate. By U. S. standards these accidents, while moderate in severity, are intolerable in their frequency. Mechanization, if it were possible, would reduce the accident rate because it would keep the laboring force away from a certain amount of contact with the stone.

Among major accidents the narrow-gage cars cause 22 pct. Boulders rolling down the face and striking workers account for 19 pct, and reducing stone with sledge hammers causes 25 pct. About 10 pct are caused by explosives, which also account for 50 pct of the fatalities. Most other fatalities are attributable to the narrow-gage cars. Occasionally stone rolling down the face has killed workers.

Suggested Assignment for Consulting Firm

A typical consulting assignment from property owners could be:

1) To investigate whether the quarries can triple output by 1960 to meet increasing demands of the Indian steel industry.

2) To determine if such expansion is in the best interests of the company.

3) To determine what methods should be employed to achieve the expansion and whether or not these methods would lower production costs and increase profit.

The first conclusion reached by the consulting engineer after examination of the operation was that, as it is currently situated in the economy of India, it is highly efficient and well-managed. The consultant is not in a position to advise an efficient management team how to improve the present operation, but he has been called to study past, present and future operation from the point of view of an outsider who is not so close to the trees that he cannot see the forest.

General view of quarries.

Although it is not the primary purpose of this article to discuss solutions to these problems, four approaches were considered by the consulting engineers:

1) Abandon the properties.
2) Mechanize completely.
3) Install partial mechanization.
4) Expand on the basis of present methods.

Why Quarries Can Not Be Abandoned: It is interesting to note the problems arising in each case. Consulting engineers considered suggesting abandonment because it was becoming increasingly difficult to maintain grade—as deeper horizons of the deposit are worked, production costs increase. The manner in which the quarries have been operated makes it difficult to adapt them to mechanized methods. However, it soon became apparent that limestone is relatively scarce in the industrialized section of India and that these are the only deposits in eastern India within the geo-economic sphere of the steel industry. The quarries are by no means exhausted. Abandonment apparently is not the answer and some compromise will have to be made.

Why Not Mechanize Completely? The next suggested recommendation would be complete mechanization, using large rotary blasthole drills, power shovel loading, haulage with 30 or 40-ton Euclid-type trucks, and mechanical crushing and sizing. As the stone does not lend itself to upgrading by sink-float it would be necessary to design a crushing plant incorporating large hand-picking areas. A complete study of this type of mechanization was undertaken. However, this apparently simple solution is beset with problems.

When the stone is coarsely blasted, broken with sledge hammers, and upgraded by hand picking,

very little material is produced —0.5 in. The quarries have no current market for material —0.5 in. Some production is used in rotary kilns at the steel plants, but for some reason the rotary kilns now require —1½-in. + ⅝-in. stone, although it is difficult to ascertain why these kilns could not operate on —¾x0-in. stone with suitable dust collection systems. It can be estimated that mechanical crushing to produce the desired flux stone sizes will produce about 17 pct of the total feed as —⅜ in. material, for which there is no present market. If the quarries ignore this situation, intending to waste the excess fines and employ mechanical crushing, operating costs will be about the same as they are with present methods.

It would be ideal if the shaft kilns in the local lime operation were replaced by rotaries, which presumably could use fine feed. But this investment is not attractive to the owners. And in India, as in similar countries striving to industrialize, the Government will not permit even the temporary unemployment this type of mechanization would create.

Assuming that the unemployment question could ultimately be solved, we now face even more serious problems. Complete mechanization would require the expenditure of some $4.8 million, and of this total about $3 million would have to be available as foreign exchange. At present the Indian Government is unlikely to permit this much sterling or dollar to leave the country. A far more serious difficulty, however, is not the capital required in foreign exchange, but the considerable portion of the operating cost that must be available as foreign credits. For example, present methods require only 18.7 pct of the operating cost to be in the form of foreign exchange; under a system of complete mechanization nearly 40 pct of operating cost would be for imports requiring foreign credits.

If all other obstacles were surmounted, there would still be the question of adaptability of labor to total mechanization. Undoubtedly the few skilled operators required could be found, and trained in a very short time. But very few of them could be women, and the laborers often prefer to work as a family unit. Again, for maximum utilization of mechanical equipment it is desirable to operate night shifts—but Indian law discourages women working on night shifts.

After careful study of complete mechanization, it became evident that, because of the wasted fines production, cost under total mechanization would not be significantly better, and the return on a somewhat substantial investment would not be attractive.

Can Partial Mechanization Be Adopted? When complete mechanization was ruled out, a study of partial mechanization seemed warranted. Since it is quite impossible to discharge any of the present labor, a desirable objective might be to provide the present labor force with enough mechanical equipment to treble production.

A partial mechanization scheme would involve drilling and blasting as currently done. The stone would be broken by hand and sorted by hand, and each group of workers would toss good stone and bad stone into separate piles adjacent to their working place. When the piles had grown to about 6 cu yd the workers would call for a front-end loader that would load good stone into 6-cu yd Dumptor-type trucks for removal to the nearest bin or perhaps directly to the broad-gage loading point. The same loading and hauling team would remove waste to a suitable waste dump.

This plan has the outstanding advantage of causing no unemployment, but otherwise it suffers from the same obstacles that penalize complete mechanization. Total capital required would be $1.8 million, of which $1.2 million would have to be foreign exchange. About 38 pct of operating cost would have to be foreign exchange, as compared with 18.7 pct under present conditions. However, this scheme offered a very attractive return on investment by lowering operating costs considerably.

Expansion with Present Methods: After it became clear that mechanization, either complete or partial, is beset with problems, it appeared that the simplest solution would be to expand by employing the same methods and equipment now in use. But this approach is not without problems also. Inasmuch as the output per manshift would increase only slightly, about two and a half times as many employes would be needed. A study of expansion by present methods revealed that about $3 million would be required, of which only $665,000 need be foreign exchange.

Superficially this seems a very satisfactory situation, but the mere presence of some 13,000 workers creates quite a few problems. Of the $3 million to be spent in such an expansion, nearly 70 pct would go for labor housing and welfare facilities. It can almost be predicted that 2.5 times the labor force means 2.5 times the human problems. Aside from the human factor, the present quarry working faces

Women employees breaking and sorting stone.

Jig-back hoist for transferring stone from level to level.

could not accommodate 2.5 times the present labor force in any 8-hr period. This being true, it is immediately suggested that the quarries operate more than one shift. But as previously stated, night shift work meets with some objection from the workers.

Unique Problem of Railroads: It has been mentioned that the railroad constitutes a special problem. Since Independence the railroads have been called upon to carry considerably more freight and have faced many operating difficulties common to railroads in general, and perhaps socialized railroads in particular. Within the stone quarry there are about 15 separate sidings. Spotting of empties and withdrawing of loaded cars appear to be handled by the same crews that operate the fully loaded trains and move stone to the division point. In the U. S. an industrial plant or mine with numerous sidings would prefer to use its own switch engine, thereby exercising complete control and coordination over the spotting of empties and removal of loaded cars. If the railroad crews were relieved of internal plant switching they might be able to devote more time to moving the main line trains. However, company switch engines offer no absolute assurance of better railroad service. If it were suggested that the quarry provide its own switch engine, the reply would probably be that the railroads have provided switching service in the past and could do so now if they were not so inefficient. And, moreover, switch engines cost foreign exchange.

Rapid car-loading systems do not exist. As the railroad becomes harder-pressed to handle the load, it applies the only pressure available under the circumstances—it shortens the demurrage time allowance and increases demurrage rates.

The narrow-gage, hand-trammed cars are without mechanical brakes of any type. The present method of stopping them is to wedge a stick under the frame and over one of the rear wheels as a fulcrum. Admittedly a mechanical brake on some 900 of these cars would be a heavy maintenance problem, but in view of the fact that the cars have caused fatalities, some effort might be made to improve the braking system.

Client vs Consumer: Finally, we arrive at evaluating the client's own point of view. The client is under pressure from a socialist government to achieve overnight what is in effect an industrial revolution. The owners of the present productive facilities are none too enthusiastic about investing additional funds, with rupees or foreign exchange, in an uncertain economic climate. There is recent indication that the Government of India may be swinging more to the side of private enterprise; however, it can readily be seen that expansion of these quarries or similar facilities may not be a first class investment.

In this particular instance the consulting engineering firm finds it is in a position between the raw material stone producer and the consumer. The consumer would like to have a flux stone containing a minimum amount of insoluble material and would like to keep in effect a price structure that is not particularly profitable to the quarry operator. On the other hand, the quarry operator steadfastly maintains that for the price he is now being paid he cannot continue to produce stone that meets specifications. It is quite possible to reduce this controversy to mathematical terms and arrive at a set of conclusions. But these conclusions cannot possibly satisfy both producer and consumer—and this is not unique to foreign countries.

It can be demonstrated mathematically that stone of the most desirable grade can be produced if the price is high enough. At the same time it can be demonstrated that if the steel industry demands only the best grade of stone regardless of price, it will ultimately deplete these deposits and be forced to rely on a very inferior flux stone, whereas if it will compromise now it can look forward to years of operation without having to use inferior stone.

Summary

It would appear that some of the problems of modernization and mechanization are common to many countries attempting rapid industrialization. Most assuredly industrialization cannot be achieved by mere weight of industrial equipment. The primary objective of industrialization should be a higher standard of living for the people who are served by it, and a country has gained very little if it depletes its foreign exchange resources, deprives its people of the means of even a meager livelihood, and disrupts their social and cultural tranquility. The engineer, when called upon to assist in these matters, finds that fundamentally the problem is no different from other engineering problems, since it involves compromise—in this instance compromise with social, economic, and political forces quite beyond his control. The industrial revolution that required nearly 150 years in Europe and North America can hardly be achieved overnight.

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Transfer bin and loading trestle.

Shaft-type lime kilns.

New Process, New Plant—

A development by Inco solves an old problem of excess iron in a nickel mill product (1) and also adds up to new profits from sales of the high grade pellet byproduct. **In brief:** Sulfur in concentrates is eliminated in fluid bed roasters (2). Following selective reduction of the roaster product in kilns using concurrent gas-solids flow (3), nickel is leached in ammoniacal solutions under atmospheric pressure (4). Permanent magnet drum separators are used for thickening in the countercurrent leaching operation, and steam kettles are used to precipitate nickel from the pregnant solution. The magnetic fines are agglomerated into 1-in. balls by pelletizing on discs (5) and firing on a traveling grate to achieve the finished product (6). Instrumentation provides the necessary close control of operating variables.

SUDBURY ore processed by International Nickel Co. of Canada Ltd. was recovered for many years as two mill concentrates, one primarily of copper, and the other mixed pentlandite-pyrrhotite. But, since iron content of the nickeliferous pyrrhotite concentrate was ten times its nickel value, capacity of smelting was limited by the need for slagging the excess iron. A process for recovering the iron content was developed after some years of research and a $20-million plant was constructed to employ the new method.

Built near Copper Cliff, Ont., the plant started operation early in 1956, scheduled for separate treatment of 365,000 tons of pyrrhotite each year. It is only the first unit of an installation which will have a capacity of more than 1 million tons per year of pyrrhotite. By early 1958, production totaled more than 200,000 long tons of 68 pct Fe pellets containing 0.003 pct P, 1.5 pct SiO_2, 0.01 pct S, and 0.15 pct Ni.

Pyrrhotite concentrate is produced in the Copper Cliff mill by grinding, flotation, magnetic separation, regrinding, and reflotation. The product contains 0.05 pct Cu, 0.75 pct Ni, 57 pct Fe, 37 pct S, 2.5 pct SiO_2 and is about 90 pct −200 mesh. Pumped 4 miles as a 20-pct solids pulp to the iron ore recovery plant, west of Copper Cliff, the concentrate is dewatered to 75 pct solids. A uniform pyrrhotite supply is sent to a four-way distributor and is carried to the roaster by rubber pipe lines.

Roasting: This is the first major step in conversion of finely-divided nickel and sulfur-bearing iron ore into lump, low nickel, sulfur-free iron ore. Upon dead roasting, the pyrrhotite (Fe_7S_8) is oxidized to hematite. Nickel originally present in pentlandite and in solid solution in pyrrhotite reports as a nickel ferrite.

Roasting temperature is about 1450°F, and the oxygen supply is controlled to produce magnetite in a ratio of about 1 Fe_3O_4:10 Fe_2O_3. This maintains oxygen content of the outlet gas below 0.5 pct, while producing an active calcine. Two 550-tpd fluid-bed units are employed in the Inco process. All calcine is withdrawn from the top of each roaster through two outlets operating in parallel, each with its own dust recovery system. Production calcine leaves the roaster through the smaller outlet and circulation calcine leaves through a large central outlet.

Roasting temperature can be controlled by varying circulating load, with excess heat recovered as steam. Calcine circulation increases residence time in the roaster, thus permitting increased feed rate without penalty to sulfur elimination.

The Inco-Lurgi design roaster is a refractory lined, cylindrical steel shell, 43 ft high from hearth to roof brick. The Lurgi grate comprises mild steel bars bolted tightly together with tapered slots between them for air flow.

Relatively coarse −20 + 60 mesh particles maintain a bed depth of 3 ft on the grate when in repose. This material is fine enough to fluidize readily, but too coarse to be carried up the upper section of the roaster shaft. Shaft gas velocity, 3.5 fps, is greater than end settling velocity of the calcine.

Four oil burners inclined 15° downward, equally spaced around the shaft and 6 ft above the grate, are used for initially heating the roaster. During heat-up, the air blast is turned on momentarily at short intervals to uniformly heat both bed and shaft—12 hr are needed to heat to 1300°F. At the end of the heating cycle, the oil burners are withdrawn and pyrrhotite pulp is fed at full flow to four water-jacketed 1½-in. diam stainless steel guns inclined 60° downward and discharging 8½ ft above the grate. Required air blast is then applied and the roaster roars swiftly and smoothly to life, its temperature rising to about 1450°F throughout.

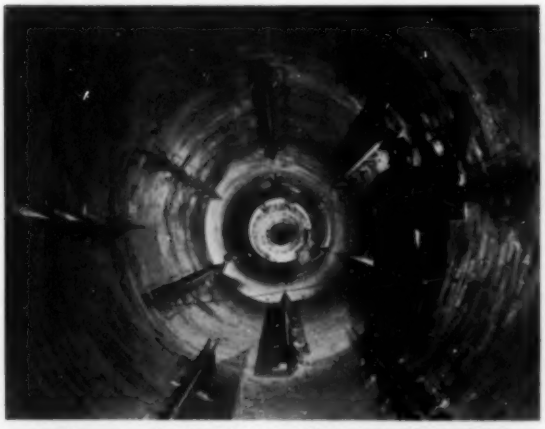
Automatic record-control equipment apportions solid, liquid, and air input to keep the fluid bed and dust suspension above it at needed temperature. Each roaster is served by a Research-Cottrell electrostatic dust precipitator which removes 99 pct of suspended matter from 90,000 cfm of gas at 700°F. This serves a threefold purpose: dust is recovered for return to process, gas is cleaned before fixation of its sulfur content, and dust pollution is prevented.

Nickel Reduction: Each of the fluid bed roaster systems is in gravity feed relationship to a rotary kiln. A rotary kiln was chosen for the reduction operation in preference to a multiple-hearth rabble furnace for reasons of gas-solid contact, capacity, simplicity, and safety, and in preference to a fluid bed furnace because of the slow selective reduction reaction. The kiln, 185 ft long, is made gas tight by Lurgi water-cooled end seals, has a 13-ft ID steel shell, and is supported at a 3 pct slope by two riding

High Grade Iron from Inco's Concentrates

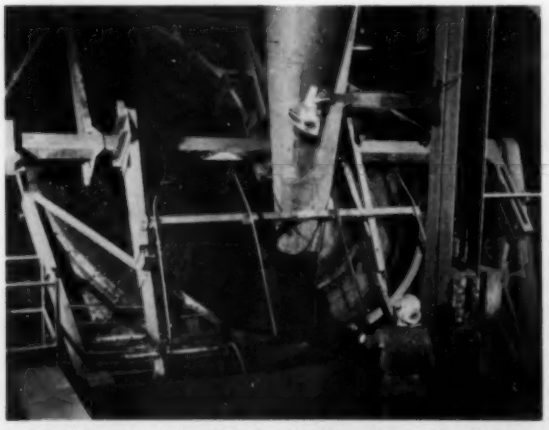
1 Tallest smelter chimney, 637 ft, dominates Inco's iron ore recovery plant. From right to left are Roaster-Kiln building, Leaching building, Recovery building, and Pellet building of $20 million plant.

2 Huge roaster's interior is refractory lined, 26 ft diam. Each of the two units employed has 550-tpd capacity, double that of any other roasters in service. Cylindrical shell is 43 ft high from hearth to roof.

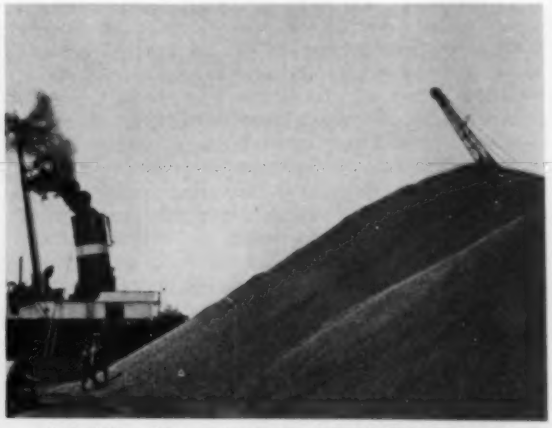


3 Gaseous reduction kiln is world's largest. Kiln is 185 ft long, has a diameter of 13 ft. Indicated oil consumption amounts to 3 million Btu per long ton of iron ore pellets. Operating temperature is 1600°F.

4 Metallics and sulfides in the kiln product are leached in ammoniacal solutions at atmospheric pressure in this building for extraction of nickel, copper, and cobalt. Note permanent magnet drum thickeners.



5 Here, one of the three Lurgi balling discs in the Pellet building is turning out about 20 long tons per hr of 1-in. pellets. Each disc is 16-ft diam, 15 in. deep, inclines at 45° angle, and turns at 4 rpm.



6 Freighter *Algoway* is seen as it loads the first iron ore shipment of the new Great Lakes season from a 25,000 ton pile of pellets, produced at the Inco plant. Loading was at Georgian Bay port of Little Current, Ont.

rolls. This is the largest known gaseous reduction kiln and is of Inco-Smidth-Lurgi design.

Roaster calcine enters the kiln at 1000°F and is rapidly raised to a temperature of 1600°F by a high pressure oil burner. Controlled kiln temperature and gas analysis produce the desired selectively reducing atmosphere. Indicated oil consumption amounts to 3 million Btu per long ton of iron ore pellets.

Kiln coolers discharge their 400°F calcine, now primarily magnetite with a little wustite, ferro-nickel, and nickel-iron sulfide, directly into one of the two agitated water quench tanks provided for each kiln. The magnetite pulp is pumped at 30 pct solids to the Leaching building.

Leaching: Reduced calcine from the kilns is leached at atmospheric pressure in aerated ammoniacal ammonium carbonate for extraction of its metal content. This involves six stages of leaching, including a grinding operation and five stages of washing. Solid-liquid separation is done by permanent magnet units. Dissolved nickel, copper, and cobalt are recovered as basic carbonate by steam distillation of pregnant solution in a stripping column followed by series kettles. The leached and washed magnetite is pumped to the Pellet building for agglomeration.

As magnetite pulp is delivered to the Leaching building by pipeline from the kiln, it is fed to a washing thickener. Overflow is discarded and underflow discharges to a pump sump for dilution to 30 pct solids. This pulp is sent to two 3x3-ft drum magnetic separators in series with a water repulp between separators. This reduces silica content of the magnetite to 2.0 pct or less. The magnetic fraction is fed at 67 pct solids to a 100-ton capacity agitated storage tank or to either of two 200-ton capacity dead storage tanks. Controlled feed to a 14x16-ft internal drum filter results in a cake of 15 pct moisture content. This cake discharges into agitated ammoniacal ammonium carbonate solution contained in the first leaching tank.

Leaching is done in 14 tanks, all 12x12 ft but varying in agitator design and speed. The tanks are separated into five countercurrent leaching stages with 3x3-ft Alnico permanent magnet drum separators used for solid-liquid separation between stages. A 9x10-ft ball mill between the second and third leaching stages constitutes, in effect, an additional leaching stage. The tanks all have provision for controlled aeration and operate at a pulp density of 40 pct solids. About 85 pct of the extractable nickel is dissolved by the end of the second stage, and only traces of nickel are present in the fifth stage solution. All equipment containing ammonia solutions in the Leaching building is vented to the Recovery building for reagent recovery.

Non-Ferrous Recovery: Pregnant solution is treated in the Recovery building for recovery of nickel, copper, cobalt, ammonia, and carbon dioxide content. After aeration, the solution is pumped through a filter press for removal of gangue and precipitated iron hydroxides. Press cake is discarded after displacement of residual pregnant solution with water. Filtrate is stored in a 90,000-gal surge tank and pumped at constant volume to the Blaw-Knox designed recovery system for metal precipitation and ammonia and carbon dioxide absorption.

After partial stripping, to about 2 pct NH_3, the solution is fed to five kettles in series where the balance of its ammonia content is stripped, and its total metal content precipitated. Soda ash is added to the kettles to free ammonia tied to sulfur and thereby insure overall metal and ammonia recovery of 99 pct or better. Basic nickel-carbonate slurry from the last kettle is thickened and filtered and then discharged into spiral dryers which lower its moisture content from about 75 pct to 40 pct. The material becomes powdery and is stored in dust-tight bins for further processing.

Agglomeration of Magnetite: Leached magnetite is received in the Pellet building and agglomerated into hard 1-in. balls by baking on a travelling grate. The process involves dewatering of the magnetite, formation of wet *green* pellets on balling discs, and drying, preheating, firing, and cooling of the pellets on a modified sintering machine. Subjection of the magnetite to high-temperature oxidizing gases for agglomerating purposes converts it to hematite and completes sulfur elimination. The sintering machine product is screened for removal of fines and shipped to market.

The leached magnetite is treated in the Pellet building to produce a concentrate of 15 pct moisture and this is stored in a 60-ton capacity rotating bin-table feeder. The feeder accurately feeds the concentrate to three Lurgi balling discs. These discs are of 16-ft diam, 15 in. deep, incline at an angle of 45° and turn at 4 rpm. Each disc has a capacity of at least 20 long tons per hr of 1-in. pellets. The disc product is transported to the sintering machine on a system of belt conveyors. The machine is charged evenly through use of an 8x11-ft re-roll belt which travels upward on an incline so that only well made pellets can roll down it. Fines and broken pellets cling to the belt and are returned to the agitated storage tank.

Lurgi Sintering Machine: The sinter machine, 8 ft 2½ in. wide, is rated at 1200 long tons per day. Charge depth is 20 in. and normally consists of 4 in. of grate layer and 16 in. of green pellets. Present fuel consumption approaches 2 million Btu per ton of product, but this will be sharply reduced when the machine is operating at rated capacity rather than the present 60 pct of capacity.

The magnetite quickly oxidizes at 800°F so that heating of the pellets must be closely controlled to prevent *flash* oxidation. Heat varies with the four zones of the unit, the material passing through stages of drying, preheating, and two stages of firing. The pallets carrying the material then pass into the cooling zone where air is blown up through the charge at a controlled rate.

High Grade Product: Fired and cooled pellets are double screened. Undersizes consist of coarse chips, for use as hearth and side-wall layers, and −⅛ in. fines for return to the agitated storage tank. Oversize consists of approximately 1-in. pellets which yield about 10 pct of −28 mesh material when subjected to the ASTM Tumble Test and analyzes: 68 pct Fe, 0.003 pct P, 1.5 pct SiO_2, 0.05 pct Mn, 0.65 pct Al_2O_3, 0.25 pct CaO, 0.30 pct MgO, 0.01 pct S, 0.05 pct Cr_2O_3, 0.15 pct TiO_2, 0.15 pct Ni, and 0.01 pct Cu. Successfully used as an open hearth charge ore in both the U. S. and Canada, the Inco product is believed to be the highest quality iron ore produced in quantity in North America.

A more detailed article on this Inco development, *High-Grade Iron Ore at Copper Cliff, Ontario*, by Paul Queneau, E. H. Bracken, and Daniel Kelly, may be found in the August 1958 issue of JOURNAL OF METALS.

TV Camera Monitors Jeffrey Skips

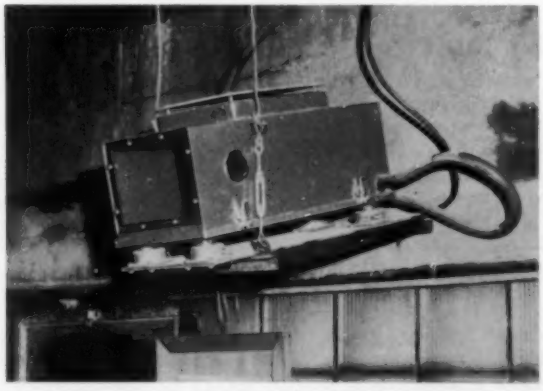
ORE at the Jeffrey mine of Canadian John Manville at Asbestos, Que., is hoisted by two 12½-ton capacity aluminum skips, counterbalanced. When the loaded skip reaches the surface it empties, via its sliding door, into a bin. Simultaneously, the skip tender, who operates at the 940 level, loads ore into the alternate skip from a 12½-ton measuring pocket. This done, he sets the skips in motion.

Problem: When moisture content of the asbestos ore is high, the ore, unknown to the skip tender, sometimes sticks in the dumping skip, preventing complete discharge. Moreover, the sliding skip doors sometimes jam and stay open after the ore is discharged. If a skip in this condition is lowered, the result is either an overflow of ore, or the ore discharges through the open skip door, down the shaft. Spilled ore must then be mucked out of the spill pocket and hoisted in 2-ton cars. Cost is high, time is lost, and the shaft is sometimes damaged.

Solution: A television apparatus was installed so that the skip tender might quickly spot improper door operation or hang-ups at the dumping station.

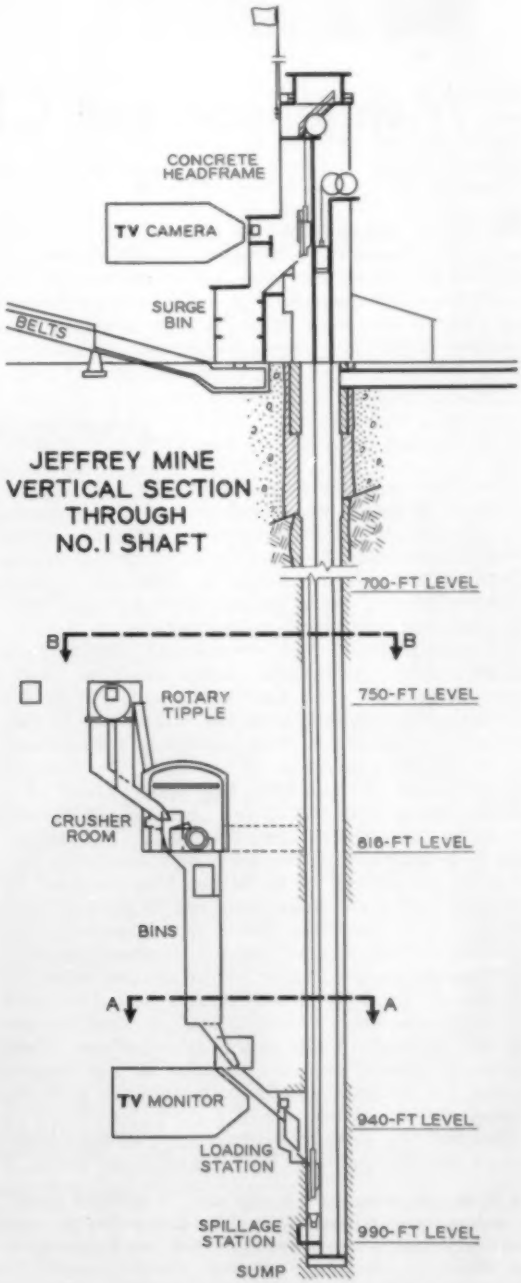
A TV camera was set up 20 ft in front of the two skip dumping areas and a monitor was installed in front of the skip tender at his station on the 940 level. A 1000-ft coaxial cable connects the units. Adjustments are made from a monitor and camera control unit located in the lamp room at surface.

The skip tender is now able to spot any irregularities in operation and prevent spills and damage.



TV camera oversees the two Jeffrey skip dumping sites at a 20-ft distance.

Tender watches monitor at his station on 940 level to check on dumping of ore skips at surface.



Manganese and Chrome Ore Outlook

by John M. Warde and Eileen P. Burke

ORES of manganese and chrome have a high order of strategic importance, both metals are basic to the metallurgy and usefulness of steel, the fabric on which our economy rests. Looking beyond the current recession and short range picture of oversupply in these ores, this review attempts to answer the following questions regarding the long-term outlook for these key commodities: By 1970, what will be the probable demand here and abroad, what are future supply prospects, and what effect is the USSR likely to have on the world market? (See summary forecast on facing page.)

Manganese Ore

The steel industry accounts for the consumption of about 95 pct of the world output of manganese ore, mainly in the production of ordinary carbon steel. The balance is met by ores of special grades essential for use in dry cells and chemicals; because of the relatively small tonnage of these ores, they have not been considered in this review.

At present, there is no commercial substitute for manganese in steel making. Aptly called the "scavenger" metal, its chief function is to minimize the harmful effect of sulphur on the rolling and forging properties of the ingot. It also serves as a deoxidizer, and as an alloy additive it improves the strength and toughness of steel. In U. S. practice, about 13 lb of manganese is added in the open hearth process for every short ton of steel produced. This manganese is principally in the form of ferromanganese, an alloy containing 70 to 80 pct Mn, obtained by smelting high grade manganese ore in blast or electric furnaces. The Free World managanese supply problem centers around the ore required for this ferromanganese production. While the preferred ore for metallurgical use should contain 48 pct or more Mn, and meet other chemical and physical specifications, no single ore is generally considered ideal. Normally several ores are blended in the furnace charge for ferromanganese production to give the desired characteristics.

Demand: As steel production goes, so goes manganese ore consumption. This is illustrated in Fig. 1 which gives the historical pattern of steel production and manganese ore production in the Free World from 1929 to 1956 with estimates through 1970. The average annual growth rate projected for steel in the U. S., 1954-1955 base, is 3 pct compared with 5 pct for the rest of the Free World. These estimates are based on an assessment of forecasts by various U. S. steel industry observers.

If steel production reaches the levels forecast by 1970, Free World demand for manganese ore for metallurgical use could grow to 9.3 million long tons of the grade now being used (46 pct Mn average). This is almost double the 5.2 million long tons estimated to have been consumed in 1956. U. S. share of the Free World demand could drop to 33 per cent by 1970, compared with 39 per cent in 1956, if the growth rates projected for steel production in the U. S. and the rest of the Free World are attained.

Table I shows U. S. manganese ore statistics for 1957, compared with 1956. Currently, the manganese ore market is in the doldrums reflecting the reduced level of output of the U. S. steel industry.

TABLE I. U. S. Manganese Ore Statistics
(Thousands of long tons)

	1956	1957
Production (Shipments)	309	325
Consumption	2,122	2,106
Imports	2,120	2,780
Stocks	1,147	1,392

Source: United States Bureau of Mines, Mineral Industry Surveys.

J. M. WARDE is Mineral Economist and E. P. BURKE is Statistical Analyst, Mineral Survey Dept., Union Carbide Ore Co., New York City. From a paper presented to the New York Section, AIME, May 1958.

Future Outlook to 1970

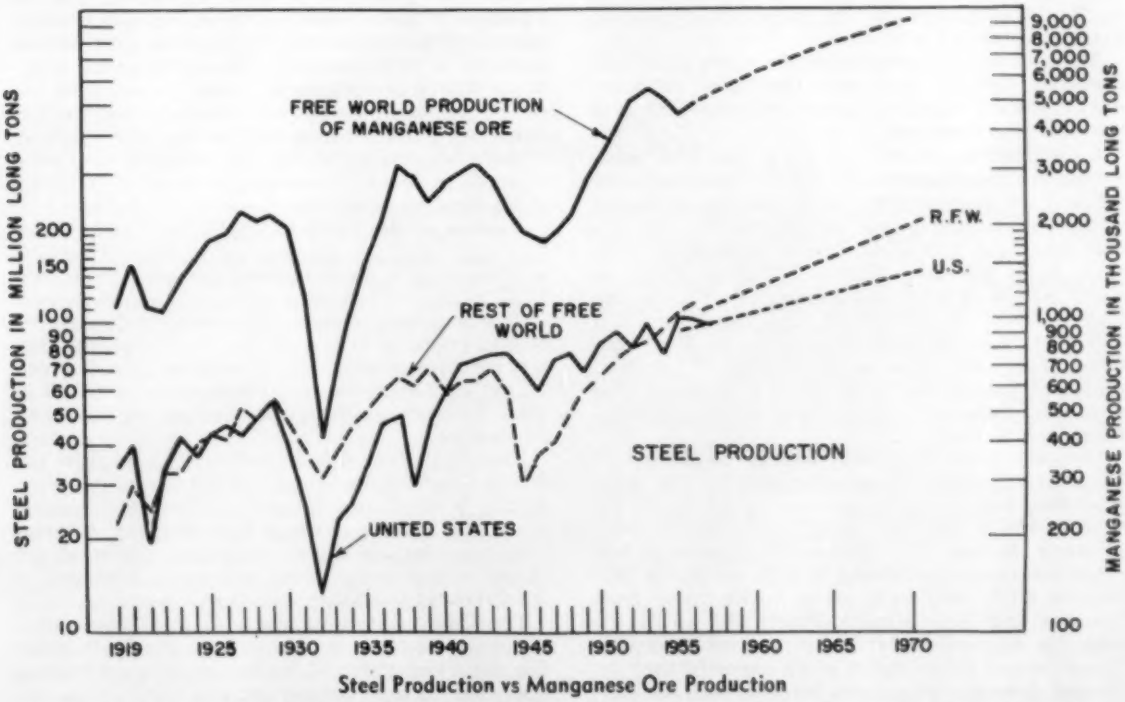
- World demand for both manganese and chrome ores is expected to increase.
- European consumption rates for both chrome and manganese are expected to grow faster than the U. S.
- The drive for industrialization and conservation of resources for home use in major Free World manganese and chrome ore producing countries will increase.
- Free World sources for manganese will remain as at present except for increases in tonnage anticipated from Brazil, new production from French Equatorial Africa and the emergence of USSR as a principal supplier.
- Supplies of lump metallurgical chrome ore from Free World sources are expected to decline—industry will be forced to greater use of friable ores and fines. The USSR is expected to increase exports of metallurgical ore to the Free World.
- Refractory chrome ore supplies from the Philippines and Cuba will decline—refractories producers will look mainly to Africa.
- The Transvaal will continue to be the principal Free World source of chemical grade chrome ore.
- Research on the economic utilization of low grade manganese and chrome resources in the U. S. will be intensified.

Reserves: World reserves of manganese ore suitable for direct shipment or for shipment as high grade concentrates after beneficiation, are estimated by the U. S. Bureau of Mines at a billion tons of which two-thirds are in the USSR. The remainder is in India, Africa, and Latin America. In addition, there are large resources of low grade manganese which could become important if advances in technology permit their economic exploitation. It is important to note that, with the exception of the USSR, not one of the great industrial nations has adequate presently usable reserves of manganese ore.

Free World Trade: Because of the bulky nature of manganese ore, transportation is a big factor. Inadequate rail and port loading facilities in the producing countries have in the past been serious obstacles to expanding production. Manganese ore generally moves over long sea routes, hence transport costs are important in determining the consumer price for manganese ore. In the case of the United States, approximately 1/3 the average price delivered to the eastern seaboard is chargeable to ocean freight. Because such a large proportion of the final cost is transport, deliveries of manganese ore are highly sensitive to changes in shipping rates. Fig. 2 shows the pattern of world trade in manganese ore in 1956.

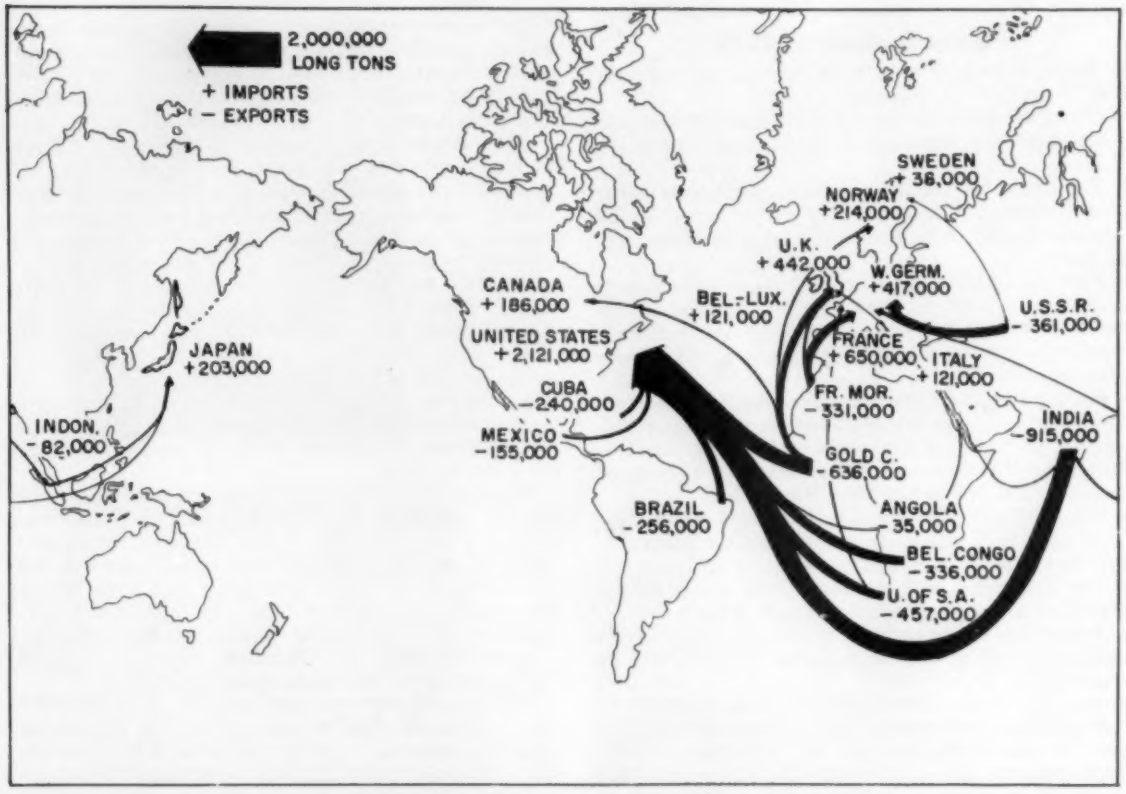
Supply: Free World production of manganese ore in 1957 amounted to about 6 million tons and was mainly in Brazil, India, Union of South Africa and the Belgian Congo. Of historical importance was the emergence of Brazil in first place as a Free World manganese ore source in 1957. The bulk of this output was from the Amapa deposit, jointly owned by Bethlehem Steel and Brazilian interests, located 170 miles up the Amazon in northern Brazil.

The Free World peacetime outlook for manganese ore supplies is good. In addition to the continuing supplies expected from current Free World sources there is a good possibility that substantial new supplies will be developed in Brazil and Africa within the next decade. U. S. Steel is active in a joint venture with Brazilian interests in the development of the Urucum deposit in western Brazil and is also



Steel Production vs Manganese Ore Production

NOTE: Free World excludes data from U.S.S.R. and countries in soviet sphere; includes data for these areas prior to their entry into the Soviet bloc. SOURCES: American Iron and Steel Institute; USBM Manganese Survey (1952), Mineral Industry Surveys, Minerals Yearbook; American Metal Market "Metal Statistics"; Stanford Research Institute "Chemical Economics Handbook".



World Trade in Manganese Ore 1956, Long Tons

SOURCES: Quin's Metal Handbook; Alexander Gakner, USBM; Statistical Summary of the Mineral Industry 1951-56, Published by Overseas Geological Survey's, London; USBM Mineral Industry Surveys; U.S. Department of Commerce.

interested in a joint venture with French interests in the development of an extensive deposit in French Equatorial Africa.

There is an increasing tendency in ore producing countries, notably India and the Union of South Africa, toward industrialization and conservation of resources for home use.

U. S. Position: In 1957, 98 pct of the U. S. manganese ore requirements for metallurgical use were satisfied by foreign ores. U. S. imports of metallurgical grade manganese in 1957 totalled 2.8 million long tons and came mainly from Brazil (30 pct), India (25 pct), Ghana (10 pct), Union of South Africa (8 pct), and Mexico (7 pct). The remaining 20 pct came from 22 other countries.

U. S. duty on manganese ore is ¼¢ per lb of contained manganese from most countries; 1¢ per lb of contained manganese from USSR and Soviet bloc countries; manganese from Cuba and the Philippines is duty free.

Domestic mine shipments, heavily dependent on Government support, reached a peak of 325 thousand long tons of manganese ore containing 35 pct or more Mn in 1957. This output came mainly from Montana, Nevada and Arizona. Shipments of low grade manganese containing 10 to 35 pct Mn in 1957 totalled 2,700 long tons, all of which came from Montana and New Mexico. Practically all of the domestic shipments went to Government stockpiles. Under normal conditions it is not expected that the present domestic output can increase substantially.

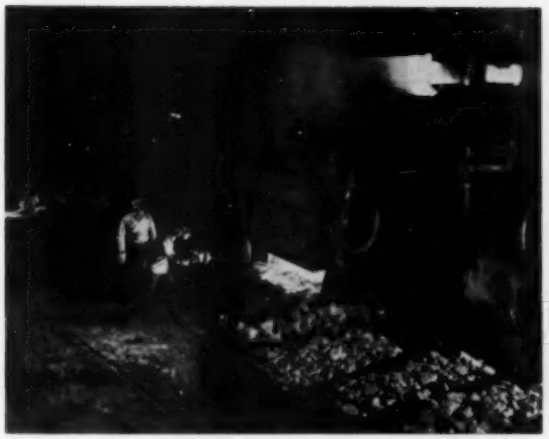
The U. S. has resources of manganese in South Dakota, Maine, Nevada, Minnesota and Oregon, which, while large in terms of contained metal are too low in grade for present commercial use. In addition to these resources, the manganese content of the wasted portion of open hearth slags produced in the U. S. Steel industry offers an important additional source of manganese should its economic recovery become possible. The strategic and critical importance of manganese and our heavy reliance on foreign supplies points up the need for continued research to develop acceptable methods for utilizing these domestic resources.

Position of the USSR*: The USSR, once a major U. S. manganese source, is believed to be the world's largest producer of manganese ore. Output in 1955 was reported to be around 4.7 million tons of which 3.5 million tons were consumed within the USSR in blast furnaces in the production of pig iron and ferroalloys.

* Based on information supplied by Alexander Gakner, East European Specialist, U.S. Bureau of Mines. Also applies to the USSR position on chrome ore.

Exports to Free World countries in 1955 from the Soviet Union totalled about 350,000 tons which went mainly to the United Kingdom, France and Scandinavia. The balance of the production went to Soviet bloc countries and Soviet stockpiles. About 90 pct of the output comes from two areas; Chiatura in the Caucasus and Nikopol in the Ukraine.

The USSR consumes about 70 lb of manganese per short ton of steel produced. Unlike U. S. practice about two-thirds of the manganese goes into pig iron used for steel making and one-third into ferromanganese for addition in the open hearth. The principal reason for this large consumption of manganese is the high sulfur content of iron ores and



Close-up of a 20-ton electric furnace in which a heat of 25-20 stainless steel is being made.

Finished ferro-alloys in stockpiles are being prepared for shipment.

coke used in the USSR and also because manganese is used as a substitute for alloying metals in short supply. The reserves of the USSR are very large and can maintain production at present or even expanding levels for many years. However, unless consumption rates are substantially lowered most of the output will be consumed within the Soviet orbit as its steel production continues to grow.

Soviet plans call for increases in iron and steel production of 7 to 10 pct annually. In order to reduce the tonnage of manganese required, efforts are being intensified to decrease the sulfur content of the iron ore and coke and to modernize and expand manganese ore production, as well as recover manganese from high manganese bearing blast furnace slags.

A new 400-ton per hr beneficiation plant for manganese ore is being installed at Chiatura to replace some 17 of its antiquated plants. This would increase recovery and improve the quality. The use of sintered iron ore, from which much of the sulfur is removed, is being expanded. Further, a new combination heavy media and centrifugal concentrator has been designed which the Soviets say will remove about 80 pct of the ash and 50 pct of the sulfur from most coals.

Whether increased production and advances in technology will free more Russian manganese for export is difficult to forecast. It is considered that the balance between USSR supply and demand will be maintained and exports to Free World countries should continue at about the 300 to 350,000-ton level for the next few years. Barring deliberate dumping as part of a campaign of economic competition, any increase in exports is expected to be gradual.

Chrome Ore

Chrome ore is consumed in three industrial fields indicated by the traditional trade descriptions of the ore as metallurgical, refractory, and chemical. These grades are based on physical and chemical characteristics; however, because of technological advances these grades are interchangeable to a certain extent.

It is estimated that about 65 pct of all of the chrome ore consumed in the Free World is employed for alloying purposes, approximately 25 pct goes into refractories and the remainder is used in chemical manufacture.

The largest metallurgical use of chrome is in the manufacture of stainless steel. Chrome refractories are used mainly in the steel industry for construction and maintenance of open hearth furnaces; chrome chemicals are used mainly in the pigment, metal treatment and tanning industries.

There are no known substitutes for most metallurgical and chemical uses of chrome. However, for refractory purposes magnesite can be substituted for chrome ore for many applications but at additional cost to the consumer.

Demand: The salient statistics on chrome ore in the United States for 1957, compared with 1956, are given in Table II. Chrome ore consumption, like manganese, is currently at a low level owing to the reduced output of steel in the United States.

Free World peacetime demand for chrome ore for all uses could go to 5 million tons by 1970, approximately 1.8 times the estimated consumption in 1956. This growth is predicated on: 1) the anticipated rise in stainless steel output; 2) increased requirements for refractories to meet the expanding needs of the steel industry, and 3) anticipated increase in the consumption of chrome chemicals.

TABLE II. U. S. Chrome Ore Statistics
(Thousands of long tons)

	1956	1957
Production (Shipments)	145	147
Consumption	1,649	1,572
Metallurgical	1,082	1,051
Refractory	424	388
Chemical	143	133
Stocks	1,095	1,446

Source: United States Bureau of Mines, Mineral Industry Surveys.

The growth of metallurgical requirements for chrome ore may be expected to closely parallel the demand for stainless steel, as indicated by the history of the consumption of metallurgical chrome in the U. S. shown in Fig. 3. If, in accordance with the opinions of various observers, stainless steel production grows at an average annual rate (1955 base) of 6 pct for the United States and 11 pct for the rest of the Free World, by 1970, chrome ore requirements for metallurgical use in the Free World could reach approximately 3.4 million tons. This represents a two-fold increase over the apparent consumption of 1.6 million long tons in 1956. If stainless steel is produced at the projected rates the U. S. share of this demand will be about 42 pct by 1970 compared with 67 pct in 1956.

The bulk of the chrome refractories used in the steel industry is composed of chrome ore with widely varying additions of sintered magnesite. Because chrome is considerably cheaper than sintered magnesite, it is normally used in the maximum percentages feasible. Should refractory chrome ore become more expensive the trend to increased use of magnesite will be accelerated.

The demand for chrome ore for refractories manufacture is projected to increase through expansion of production of crude steel. At the assumed growth rates for crude steel production here and abroad, chrome ore consumption for refractories purposes in the Free World by 1970 could reach 1.3 million long tons. This increase would be about 1.4 times the estimated 1956 consumption level of 900,000 long tons.

If the average annual post war growth rate for chrome chemicals of about 3 pct (base 1954-1955) is assumed to continue through 1970, chrome consumption for chemical use in the Free World is expected to reach 437,000 long tons or 1.2 times the estimated consumption of 361,000 long tons in 1956.

Reserves: The Transvaal and Southern Rhodesia account for an estimated 80 pct of the lode chrome reserves of the world. The Transvaal's reserves of chemical ore are measured in tens of millions of tons and Southern Rhodesia's reserves of standard and marginal metallurgical ore and refractory ore are very extensive. Turkey also has large reserves. New Caledonia is currently an important source of high grade metallurgical ore, but its reserves have not been fully defined. The Philippines is the principal U. S. source of refractory chrome ore, but reserves are being depleted faster than new deposits are being found. The Philippines also have some reserves of metallurgical ore. Cuba is the second largest U. S. source of refractory ore but its reserves are not extensive. Among the other Free World sources are India, Pakistan, Sierra Leone and Greece.

In the Soviet sphere, the USSR is reported to have extensive deposits of chrome ore and Albania's reserves are said to be substantial.

In addition to the commercial reserves and subgrade resources contained in the world deposits of lode chrome ore, large potential sources of chrome occur in chromiferous laterites in Cuba, the Philippines, Celebes, and the USSR. Cuban reserves of such material are estimated by the U. S. Bureau of Mines at 3 billion tons containing about 50 million tons of chromic oxide.

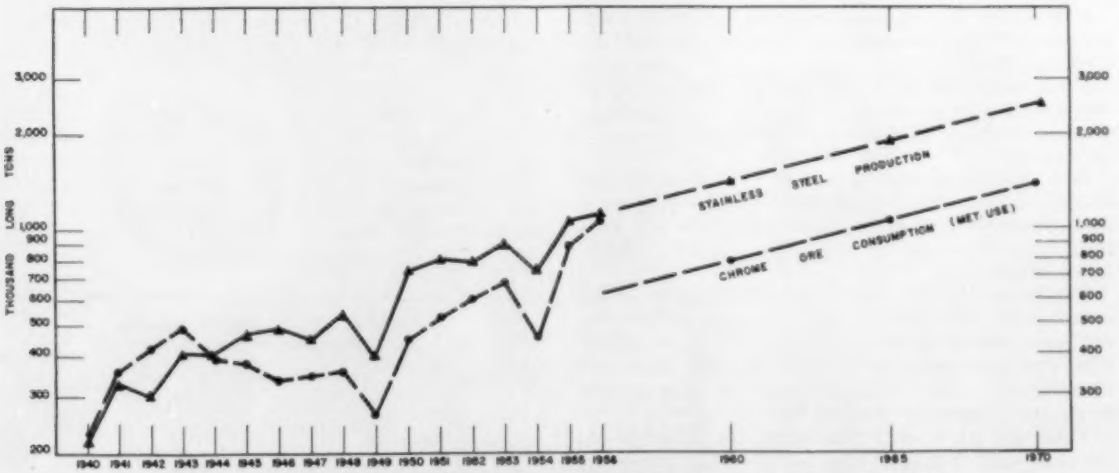
Free World Trade: With the exception of the USSR, chrome ore production is in underdeveloped areas, hence the bulk of the world's output enters international trade channels. This trade pattern is illustrated in Fig. 4.

As in the case of manganese, transportation is a key factor and inadequate transportation facilities in the Free World producing countries has hindered deliveries in the past. Because of the distances involved ocean freight makes up a substantial part of the cost of the ore in Free World countries.

Supply: Chrome ore production in the Free World in 1957 amounted to about 3.5 million tons and was mainly in four countries: Turkey, Southern Rhodesia, Philippines and Union of South Africa.

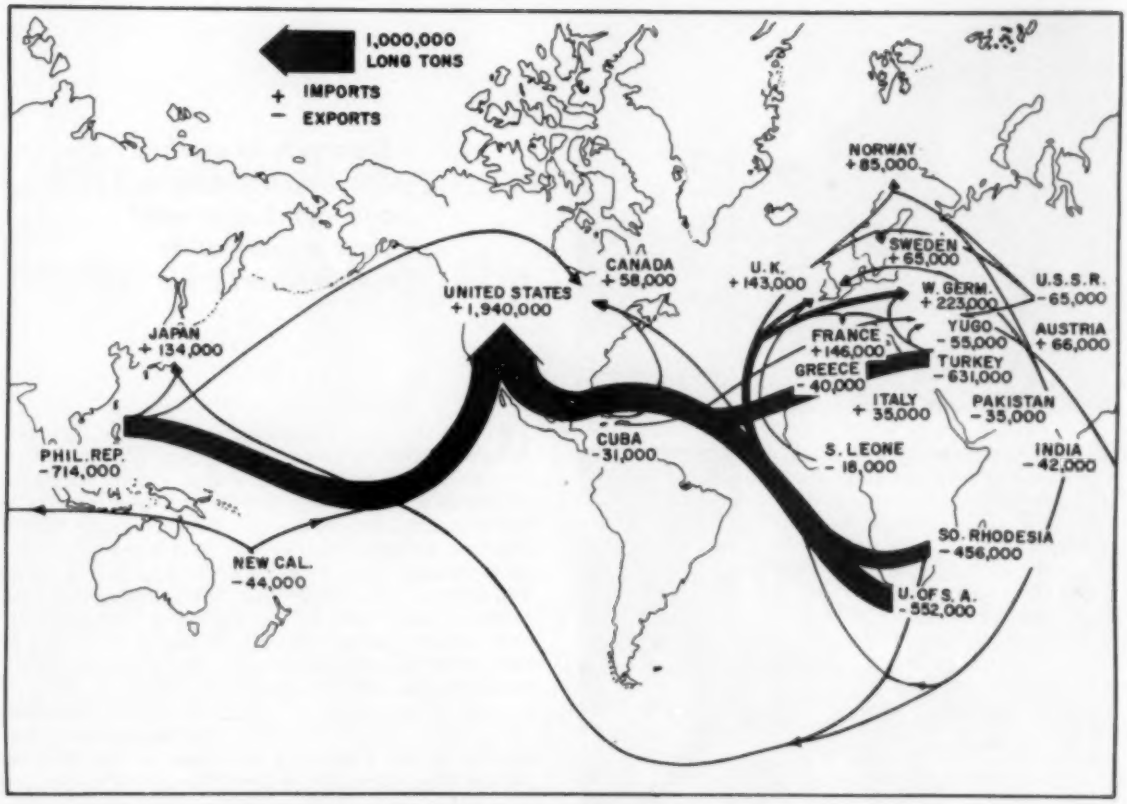
It has been estimated* that world reserves of lode depostis by type are roughly as follows: High grade metallurgical lump, 15 to 20 pct; high alumina refractory 2 to 3 pct; and high iron chemical, 75 to 80 pct. In contrast, the use pattern over the last

* Personal communication, T. Thayer, U. S. Geological Survey.



United States Chrome Ore Consumption for Metallurgical Use and Stainless Steel Production 1940-1956 with Projections at 6 pct through 1970

NOTE: Chrome ore consumption projected from the average of 1953 and 1954, as later years reflect Government stockpiling of ferrochrome. SOURCES: AMM "Metal Statistics"; AISI; USBM Mineral Yearbooks and 1955 Preprint, Mineral Industry Surveys.



World Trade in Chrome Ore 1956, Long Tons

SOURCES: Statistical Summary of the Mineral Industry 1951-56; USBM Mineral Industry Surveys; U.S. Department of Commerce.

decade has been roughly 50 pct high grade metallurgical lump; 35 pct refractory and 15 pct chemical.

If Free World demands increase as projected, supplies of high grade lump ore presently required for metallurgical use and high alumina ore preferred in the U. S. for refractories manufacture, are expected to become progressively short. This will require significant changes in metallurgical technology to permit the increased use of friable ores and ores of lower grade to meet these demands. It is anticipated that principal Free World sources of chrome ore through 1970 will continue to be about as they have in the past with a significant shift to Southern Rhodesia and the Transvaal for refractory ore as Philippine and Cuban reserves become depleted.

U. S. Position: Practically all of the chrome ore consumed in the U. S. is imported. In 1957, chrome ore imports amounted to 1.8 million long tons of which 25 pct came from the Union of South Africa, 25 pct from the Philippines, 24 pct from Southern Rhodesia and 18 pct from Turkey. The remaining 8 pct was supplied from 6 other countries.

Known U. S. reserves of chromite occur in California, Montana, Oregon, and Alaska. Some of the chrome ores in California, Oregon, and Alaska are technically acceptable but cannot be mined at current competitive prices. Extensive deposits of low grade reserves ore not acceptable in present practice occur in Montana and Oregon.

Production (shipments) in 1957 amounted to 147,000 long tons. All output was from California, Montana, Oregon, and Alaska. About three-fourths of the production was submetallurgical grade concentrate derived from ores of the Mouat Mine in Montana which is operated by the American Chrome Co. with the aid of a loan and purchase contract by the Government.

Virtually all of the domestic output was purchased by the Government at incentive prices under the Purchase Program for domestic ores and concentrates and under the terms of a contract with American Chrome Co.

Large scale exploitation of U. S. reserves awaits the development of economic methods for utilization of low grade ores. A start has been made in this direction by the establishment of a pilot plant for the manufacture of high carbon ferrochrome in Nye, Mont. Efforts must be intensified to meet our needs in time of national emergency.

Position of the USSR: The chrome resources of the USSR are known to be extensive. Output in 1956 was estimated at 600,000 long tons, the bulk of which was used within the Soviet Union, or went to Soviet bloc countries or Soviet stockpiles. About 65,000 tons was exported to the United Kingdom, Germany, Norway, and Sweden.

Formerly a principal Free World source of metallurgical ore, the USSR is again entering the world market. It is believed that in the foreseeable future the USSR will continue to export in the range of 70,000 to 100,000 tons. It is also to be expected that exports from Soviet dominated Albania to the Free World will expand for foreign exchange.

Acknowledgment: The authors express their appreciation to Dr. Olaf N. Rove and Edwin M. Weiss of the staff of the Union Carbide Ore Company for their assistance in the preparation of this article.

Proximity to market and low production cost make expanded slate a commodity with a future.

BY far the most conspicuous of the Pennsylvania slate districts is that extending from the New Jersey line at the Delaware Water Gap westward almost to the Schuylkill River. This covers parts of three counties in east-central Pennsylvania: Northampton, Lehigh, and Berks. The most important development, both in geographic size and product importance, is in Lehigh and Northampton counties.

The greater part of the region is underlain by only one formation—the Martinsburg, consisting of slates, clay slates, and sandy shales, all of the Ordovician period. The slate-bearing Martinsburg formation is underlain by Cambro-Ordovician limestones. Immediately overlying the Martinsburg formation is the Tuscarora quartzite of the Silurian period. The Martinsburg formation itself is divided into three distinct divisions, termed simply: the upper, the middle, and the lower members. Commercial slate has been extracted from all of these members, but the formation of greatest importance is the upper member, representing 2600 ft of the total formation thickness of nearly 11,000 ft. The upper member is commonly referred to as the "soft slate" and consists of three facies: 1) beds of blue-gray, very sandy, almost quartzitic slate, in many places, approximately a medium-coarse sandstone with calcareous cement; 2) blue-gray sericitic

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Shovel at the quarry loads slate for the plant, where it goes through primary and secondary crushers to surge pile, from which the belt (foreground lower picture) carries it to grates.

Slate is expanded on the endless grate beyond the ducts. These ducts supply process air and cooling air for the expanded aggregate.

Utilization of Pennsylvania Slate for Expanded Aggregate

by Frank D. Hoyt

slate—the dominant rock type of this member—with occasional chloritic beds; and 3) dark gray or virtually black, highly carbonaceous beds, referred to locally as "ribbons."

The "soft slate" consits of beds which are not uniform in quality. Some of these beds are not commercially valuable. Thickening and thinning through folding, as well as faulting, also have complicated the economic distribution of these slates. Wasteful extraction and processing methods have resulted in a large supply of discarded slate awaiting utilization.

Research Enters the Slate Picture

In 1943, John N. Hoffman, State Senator and slate industrialist, succeeded in establishing a grant from the Commonwealth to The Pennsylvania State University for a slate research project to improve the economic position of the industry by expanding the uses for slate and by developing effective utilization of waste slate.

The initial four years of the slate research program produced much new data on mineral, chemical, and physical properties of Pennsylvania slate as well as netting some outstanding practical results concerning the utilization of waste slate. This information was subsequently published in Bulletin No. 47 of the Pennsylvania State University's Mineral Industries Experiment Station.

When additional State funds were forthcoming the Slate Research Program entered a plant development phase to seek low-cost production methods.

The processes employed in the manufacture of competitive products were scrutinized with an eye toward simplification and improvement. It was thought that if the costly rotary kiln employed in converting various shalelike products into expanded aggregate could be eliminated this would result in a production method with low capital cost.

A corporation of local businessmen was formed to explore the possibility of commercially employing a sintering process to produce an expanding aggregate from waste Pennsylvania slate. Relying heavily upon material available to them in Bulletin No. 47, the investigators for this corporation were soon satisfied that such a venture was financially sound and a plant site was selected in the Bangor-Pen Argyl area, Lehigh-Northampton slate district.

The Exalite Corp. of Bangor, lone producer of expanded slate aggregate in Pennsylvania, operates its plant on the North Bangor Slate Co. property and utilizes raw slate with the chemical analysis given in Table I. The various chemicals listed in this table are combined mineralogically as follows: quartz 44.75 (pct); plagioclase-feldspar, 9.90; chlorite, 5.32; illite-sericite, 15.15; calcite, 11.05; dolomite, 4.51; and pyrite 9.25.

Although there are numerous theories as to what occurs when a material such as slate is subjected to temperatures that can induce bloating, most com-

Red hot clinker is continuously conveyed to the final crushing plant. Product density depends on material size and varies from 24 to 41 lb per cu ft.

Cooled clinker is crushed and sent to the screening plant where it is graded coarse, medium, and fine, before stockpiling ready for shipment.

Table No. 1: Chemical Properties of Pennsylvania Slate (Bulk and Expanded States)

Ingredients	Bulk State(—½ In.) 85 Lb per Cu Ft	Expanded State 24 Lb per Cu Ft
SiO_2	57.17 pct	67.24 pct
Al_2O_3	14.04	3.13
Fe_2O_3	8.45	5.29
CaO	3.79	1.58
MgO	2.66	0.72
TiO_2	0.67	—
S	2.73	SO_3 0.29
C	2.17	—
CO_2	5.54	—
H_2O @ 110°C	3.18	1.31
	98.70 pct	99.56 pct

mercially minded individuals accept it as fact and delve no further. A simply worded explanation of what actually does take place could be phrased in the following manner:

The bloating needed to change slate or a similar material into an expanded aggregate is caused by the formation of various gases when oxygen (supplied in a large part by the existent aluminum and ferric iron oxides) reacts with the carbonaceous materials present. During expansion, a reducing atmosphere is desirable though not essential, because the iron oxide thus formed will serve as a fluxing agent. Controlled laboratory tests have shown that almost all expansion takes place at the heat of incipient fusion while the slate is in a pyroplastic condition and has sufficient viscous glass phase to maintain the necessary closed pore structure.

Aggregate Production Cycle

The Exalite plant is capable of producing 1200 cu yd or more per day on three-shift operation with a crew of about eight working all phases of the operation on each shift. Total daily production is contingent upon depth of clinker passing from the furnace and for this reason it may vary from time to time.

The production cycle begins with a 1½ cu yd power shovel loading waste slate into a small fleet of 10-ton dump trucks. At the mill receiving ramp slate is dumped onto a standard fixed grizzly with 12-in. openings. Oversize is reduced to size with a compressed-air hammer. Grizzly undersize drops into a 24x168-in. primary gyratory crusher with a 3½-in. discharge setting. Discharged material is fed by 30-in. belt feeder onto an inclined 24-in. belt conveyor which discharges onto a double-deck vibrating screen. The two vibrating screen decks, with opening of 2 in. and ½ in., respectively, pass oversize to a secondary crushing unit, while the undersize (—½-in.) goes direct to a 24-in. stockpiling conveyor. The secondary crusher (gyrasphere type) reduces oversize to about ½-in. size and deposits it on a 24-in. recirculating conveyor that discharges onto the primary conveyor midway between the primary crusher and the vibrating screens.

A ½-cu yd front-end loader transfers slate feed a short distance from the stockpile to a dual hopper where it is blended with anthrafines (No. 4 buckwheat anthracite coal).

The blending hopper feeds the mixture, approximately 94 pct slate to 6 pct coal by volume, to a screw feeder that in turn discharges onto a small belt-flight conveyor. The flight conveyor supplies a feeding hopper that maintains a uniform feed flow onto one of two 30-ft shallow bed sintering furnaces. At the present time these are the only two such furnaces in operation in Pennsylvania.

The continuous grate furnace has 12 forced firing nozzles, in line, on 5-ft centers, diametrically opposed at a 24-in. elevation above the traveling grate level. The burner nozzles adjustable to permit flame directing, are fired with No. 4 fuel oil and in addition the process liberates some heat. Air is drawn downward through the firing zone by a 54,000 cfm centrifugal exhaust fan used in conjunction with a cyclone dust collector. Since the sole source of primary air within the furnace is the series of ports that surround the burner nozzles themselves, the draft mechanism creates a reducing atmosphere within the furnace. The temperature immediately above the fired material ranges from 2150° to 2250°F. Firing time is 2 min 15 sec.

Bulk material entering the furnace weighs 85 lb per cu ft and in expanded form the density, depending upon the material size, will vary from as low as 24 to as high as 41 lb per cu ft. The low density material is desirable for structural concrete purposes while the higher density material is employed where great strength and fine texture is preferred.

After the expanded aggregate leaves the furnace it travels an additional 25 ft on the same grate that carried it through the firing zone. This additional travel, in free outside air, is supplied with four ventilation ducts identical to the six that support combustion within the furnace proper. By maintaining these additional ducts either open or closed, control is exercised over continued combustion if needed, as well as over the required cooling that precedes final size reduction. Total process time on the continuous grate is less than 4 min.

Clinkered material discharges upon an inclined fixed grate permitting unfired —⅛ in. material to pass through for recirculation. Oversize goes directly to a long 5-ft wide conveyor of design similar to that of the traveling grate in the furnace whereby the temperature is reduced sufficiently to permit discharge into a chaser or pan mill. The still warm material is reduced to —¾-in. and conveyed via 24-in. belt conveyor to a final screening and processing stage.

At the grading mill, the crushed material is sized on a vibrating double-deck screening system with ⅜ and ⅛-in. openings and piled in three distinct areas by means of gravity discharge chutes and stockpiling conveyors. The three sizes (one for each stockpile area) are ¾x⅜-in. (weight 24 lb per cu ft), ⅜x⅛-in. (30 lb per cu ft), and —⅛-in. (41 lb per cu ft).

At this point, Pennsylvania slate has come full circle from the wastepile to the stockpile, having been converted by heat from rubbish to an excellent structural ingredient named Exalite by the producting corporation. Actual product price is $3.07 per cu yd f.o.b. Bangor, Pa.

Though only on the market two years, Exalite has already developed a wide variety of uses in the manufacture of masonry blocks, structural beams, slabs, planks and roof sheets. The standard size 8x8x16-in. masonry unit made from fine and coarse Exalite, cement, and sand consistently tests in the neighborhood of 1200 psi, well above the required ASTM specification of 1000 psi for Grade A hollow load bearing concrete masonry units. Proximity to market, and a relatively low sales price (made possible by a relatively low fuel expenditure) make expanded Pennsylvania slate a commodity with a future.

Bump Symposium

Progress in Control

Bump damage at Sunnyside Mines, December 1957.

This issue presents the first of several articles making up the Bump Symposium, which was held at the 1958 Annual Meeting of AIME. Other Symposium papers will appear in the September issue of MINING ENGINEERING.

THE term *mountain bump* describes the sudden rupture of one or more coal pillars under excessive stress. These bursts occur with varying degrees of violence and sometimes include adjacent strata, especially the bottom rock. Many failures do not develop enough violence to be dangerous and are regarded as an aid to coal production, but severe occurrences are accompanied by tons of flying coal, dense clouds of dust, and excessive gas emission. Such bursts sometimes throw heavy machinery several feet. Major factors to be considered in the problem are the nature of the strata above and below the seam and the depth of cover.

Bumps are classified as to their nature, extent of damage, and point of occurrence, e. g., *face bump, coal bump, high side bump, low side pavement bump,* and *district bump.*

The problem is extremely complex, and it cannot be over-emphasized that preventive measures, if they are to be successful, must be based on a thorough study of conditions in the individual mine. In western Canada, for example, the McGillivray mine, operating in a 9-ft seam at 2000 ft, has experienced severe bumps, but there have been no occurrences in the International mine, which operates in the same coal seam at 2400 ft, where the coal averages 17 ft thick. Differences in conditions governing the operation of these two mines are described in one of the following articles (see page 883). Again, most bumps in coal mines take place along pillar extraction lines, but at the Sunnyside mine in Utah they also occur a long way from active workings and sometimes in virgin territory. It is usual, too, for such failures to occur under fairly deep cover. But at Sunnyside, to cite only one instance, there have been disturbances along the main fault zone under less than 500 ft of cover.

All too often conditions favorable to bumps are revealed only by actual mining—at Springhill No. 2 mine, drilling in roof and pavement strata disclosed a 60-ft sandstone bed after operations had started—and where extraction has advanced too far for preventive measures to be incorporated in the mining plan, districts have had to be abandoned. But in an era when premium ores are being rapidly depleted in the face of rising demands, abandonment is not easily justified. There must be systematic planning to eliminate coal mine bumps, insofar as this is possible. As in the Gary district of West Virginia (see page 888) much has been accomplished by planned operations based on known factors in bump control. But even this is not enough. Precise instrumentation is needed to indicate where bumps are likely to occur, and in both the U. S. and Canada stress analysis studies are being carried out with this object in view. These pages reveal the progress being made.

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Edward Thomas

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Woods G. Talman and John L. Schroder, Jr.

Next month:

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John Peperakis

Deep Coal Mining in Springhill No. 2 Mine
W. F. Campbell

Coal Mine Bumps Can Be Eliminated
H. E. Mauck

Causes and Control of Coal Mine Bumps
Charles T. Holland

The Transactions pages appearing in MINING ENGINEERING *during 1958 will subsequently appear in AIME Transactions Volume 211, and may be permanently referenced to that volume.*

U. S. Bureau of Mines Investigations and Research on Bumps

by Edward Thomas

THE late George S. Rice was active in the investigation of bumps, particularly in the last ten years of his career as chief mining engineer of the U. S. Bureau of Mines. Since most of his investigation was carried out in Great Britain, continental Europe, and—to a lesser extent—Canada, his thinking on prevention was influenced considerably by the experience of those countries. It is not surprising, therefore, that when he was called upon a few years before his retirement to investigate bumps in the U. S. and suggest ways to prevent them, he turned to longwall mining. A longwall method had been most successful in combating the bump hazard in mining coal under deep cover, especially in Great Britain, but the prevailing method there at the time was advancing longwall mining, which he knew was uneconomical under U. S. mining conditions. For this reason he proposed a modified retreating longwall system that he believed included the best features of the advancing method.

As brought out by Rice,[1] if the cover is 2000 ft and 50 pct of the coal is extracted, the static load on the remaining pillars will be about 4000 psi, which exceeds the ultimate crushing strength[2] in most instances. If the pillar coal is overloaded before a pillar line is established, then the abutment zone preceding a line of extraction is no place to split pillars or extract them by any method other than an open-end system. Rice therefore advocated open-end mining, preferably by longwall, but he was willing to compromise with long-face mining if the longwall method was not acceptable.

Rice's system was put into operation in a mine in Harlan County, Kentucky,[3] but subsequent experience has shown that it did not take into account two important factors—avoidance of pillar-line points and maintenance of adequate development in advance of the pillar-line abutment area.

For ten years after Rice's retirement the USBM did little investigation and research on bumps, chiefly because so few were occurring that there was not much cause for alarm. But in 1951 there were three occurrences involving fatal injuries, and the Bureau began a statistical survey in that year. C. T. Holland, head of the department of mines at Virginia Polytechnic Institute, was retained as a consultant.

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The resulting study[4] of 117 case histories brought out these important conclusions:

1) Almost invariably the bump occurred in a locality affected by the abutment zones of one or more pillar lines.

2) In most cases the locality of the bump was influenced by the abutment zones of more than one pillar line. The term *pillar-line point* has been used for many years in the Appalachian region for such a situation. *Point* is used in the geographical rather than the mathematical sense.

3) In pillar-line extraction the following practices are safest in preventing bumps:

a. The mine layout should provide for pillars of uniform size and shape along the extraction line.

b. The mine layout should be planned so that no development need be done in the abutment zone of a pillar line.

c. The layout should permit open-end extraction of pillar lines from the next goaf, so that it will not be necessary to resort to pocket mining, splitting pillars, or any practice that will involve driving in the direction of the goaf within the abutment zone.

d. Pillars should be large enough to support area without undue roof and floor convergence before establishment of a pillar line.

These are, of course, generalities, and while they are useful in laying out areas where bumps can be expected, they are of limited help in many mines that were committed to a system of mining before it was realized that they were subject to bumps. Under such conditions it becomes necessary to choose between the following alternatives:

1) Abandon the territory, except for pillars that offer no extraction problems.

2) Through experience select the pillars that are most heavily loaded, and, by augering, induce bumps from a safe vantage point so that impinged loads are relieved. This method was first developed at the Gary, W. Va. mines of U. S. Steel Corp. and later adapted to mining thick coal beds at Kaiser Steel's Sunnyside mine in Utah. No scientific method is available to determine where to drill within a loaded pillar.

Although this method of unloading has worked very successfully at Gary—with one exception—

loaded pillars cannot always be pinpointed so readily, and no effective instrumentation has yet been devised to determine relative loading on various parts of a given pillar or the extent of relief obtained within the pillar after bumps have been triggered by drilling. There is a possibility of utilizing the microseismic equipment developed by Leonard Obert of the USBM, used with some success to predict rock bursts in deep ore mines. However, such use entails drilling holes for inserting geophones, and this might be extremely hazardous in a heavily loaded pillar.

Another possibility—one the Bureau intends to explore soon—is closer correlation of surface features, faulting, bedding, and other aspects with the loading and relief of pillars. At the same time an attempt will be made to measure minute differential movements along fault planes and correlate them with these data.

References

[1] G. S. Rice: *AIME Trans.*, 1934, vol. 19 (Coal Division).
[2] F. L. Gaddy: A Study of the Ultimate Strength of Coal as Related to the Absolute Size of the Cubical Specimens Tested. Department of Mining Engineering, Virginia Polytechnic Institute.
[3] J. F. Bryson: *AIME Trans.*, 1936, vol. 19 (Coal Division).
[4] C. T. Holland and E. Thomas: Coal Mine Bumps: Some Aspects of Occurrence, Cause, and Control. *USBM Bull. 535*, 1954.

Discussion of this article sent (2 copies) to AIME before Sept. 30, 1958, will be published in MINING ENGINEERING.

Ground Stress Investigations in Canadian Coal Mines

by A. Brown

RAPIDLY rising world demand for mineral products has accelerated depletion of the more readily accessible ores, particularly those of premium grade. Operations must proceed at a faster rate to deeper horizons, where there are problems of ground control that restrict economic recovery of the mineral and introduce new hazards to mine personnel. For some of the new Canadian mining fields severe problems of ground stress are still in the future, but much of Canada's mineral output comes from well established mines that have reached considerable depths.

It must also be anticipated that the depletion of premium grade ores will eventually necessitate mining low grade material at competitive cost, and unsolved problems of ground control can materially increase costs. Studies of ground stress phenomena in underground workings are therefore considered a present-day necessity, especially since these investigations must be a long-term effort owing to the highly complex nature of the problem and the difficulty of making full-scale observations.

In recent years the Mines Branch of the Department of Mines and Technical Surveys in Canada has conducted such an investigation. This report of the work is primarily concerned with stress problems in some Canadian coal mines and, in particular, with mine bumps.

Mines Branch investigations of this and related problems are carried out by a small team of mining engineers and physicists who, with assistance from geologists, pool their special skills in an integrated program. These Canadian investigations combine a field and laboratory approach. Since data obtained under contrasting mining conditions allow useful comparisons of ground behavior under stress, this article will present data gathered under a wide range of Canadian coal mining conditions. Two contrasting longwalls in eastern Canada will be discussed and two dissimilar pillar extraction operations in western Canada.

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Locale of Observations

In eastern Canada observations are being made in the collieries at Springhill, Nova Scotia. The district's No. 2 mine, which has a history of bump occurrences dating back to 1917, is currently being worked at a depth of 4200 ft. The mining method is longwall retreating along the strike and the practice is to retreat three walls in line, each about 350 ft long. There is no machine cutting or shooting—the coal is hand-picked and hand-loaded onto face conveyors.

There are three rows of hardwood chock block supports parallel to the coal face. These supports are built during the two daily coal loading shifts, and the rear line is withdrawn during the midnight shift. The goaves are partially packed by stone midwalls 12 ft wide which are built forward daily in step with the face advance. The seam dips at 15° and averages 9 ft of strong, well cleated bituminous coal enclosed in competent beds of shales, sandy shales, and sandstones of Carboniferous age. The bumps rarely disturb the retreating longwall faces but manifest themselves as violent upthrusts of pavement in the levels leading to the walls.

Observations have also been made in Springhill's No. 6 mine, which operated in a 5-ft seam of coal at a depth of about 2500 ft. Although No. 6 mine was

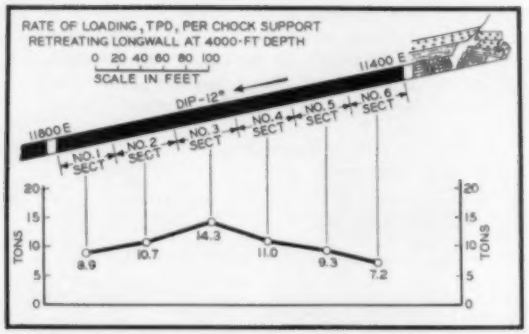

Fig. 1—Side view of longwall face in Springhill No. 2 mine, with graph showing rate of loading on artificial supports in different sections of the face.

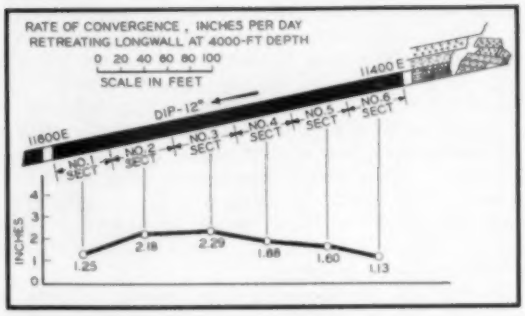

Fig. 2—Side view of longwall face in Springhill No. 2 mine, with graph showing observed rates of closure.

not as seriously affected by bumps as the No. 2, it was possible to make valuable comparisons regarding ground behavior in two dissimilar operations in the same coal field. As indicated, seam height and overburden were significantly different. Also, the wall faces in No. 6 mine were advancing, not retreating, and they operated on a daily cycle of undercutting, shooting, and loading. Lastly, the face observed in No. 6 mine was worked as a single unit and not in a combination of three as in the deeper operation. Face and gob supports were similar in both mines.

In western Canada, investigations into mine bumps have been conducted in the Rocky Mt. region in the Crowsnest Pass coal field, which has been affected by incidents of violent stress relief since 1907. The mining method generally employed in these thick, pitching seams is a retreating pillar extraction, but a modified form of longwall is used in a few mines where pitches are moderate. No packing is built in the goaves in either method and total caving is practiced. The enclosing strata, of Lower Cretaceous age, have been heavily faulted by mountain building forces and metamorphosed into unusually competent beds of shales, sandstones, and conglomerates. The orogenic stresses have also upgraded these Lower Cretaceous coals to medium volatile rank, but the accompanying processes of intense folding and extrusion have weakened them structurally and destroyed practically all evidence of bedding planes and cleat. Strata deformations ahead of extraction faces are of much less magnitude than those observed in the carboniferous measures of eastern Canada, and the less orderly advance of extraction lines tends to obscure trends in strata behavior. Even well to the rear of the extraction lines, ground falls are usually limited to the immediate roof beds, and it appears likely that long, flat arches are established that extend for considerable but as yet unknown distances into the goaves. A further interesting point of rock behavior is that although the strata are highly faulted careful measurements have failed to indicate any slippage across such discontinuities even at and behind the extraction faces.

The bumps are characterized by a violent upheaval of the floors and generally occur on or near the extraction line. There have been, however, early incidents in the Fernie area of the Crowsnest coal field where multiple roadways leading to large areas of total extraction were affected at greater distances. Usually the bumps are associated with broad, totally extracted areas under competent roofs that are able to sustain wide unsupported spans. In some of the earlier occurrences they have been attributed to the failure, over broad areas, of inadequate coal pillars.

To obtain a comprehensive understanding of ground behavior associated with longwall and pillar extraction methods, it is considered essential to attempt observations in the three zones represented by the extracted area, the production face, and the solid coal into which the face is advancing. It is also considered advisable, in order to obtain comparative data, to conduct such observations in both *bumping* and *non-bumping* mines. Observations in the open workings, as represented by the production face and its servicing roadways, usually include measurements and the loads imposed on artificial supports. For such purposes a number of reasonably reliable devices are available. The greatest difficulties lie in designing apparatus for observing stress changes in the solid strata and for remote measuring of closure and the re-establishment of ground loads in totally extracted and inaccessible areas. Since a knowledge of what transpires in these two zones is considered essential to further progress in ground stress investigations, considerable importance is attached to stress analysis studies leading to instrument development. A serious handicap in the selection and design of measuring techniques is created by the necessarily strict mining laws governing the use of electrically operated devices in coal mines. For mutual benefit, the Mines Branch promotes close liaison with research groups contesting with similar problems in other countries.

Within the limitations of this discussion it is possible to indicate briefly the object of various underground and laboratory programs and to present some examples of what has been observed.

Ground Behavior at Extraction Perimeters

To deal first with what may be broadly classified as *open workings,* observations have been concerned primarily with ground behavior on the edges of solid coal bordering totally extracted areas of the seam. Knowledge of wall closures and support loads along these edges gives some indication of how the ground loads are imposed on the solid coal and also the manner in which strata equilibrium is being restored in extracted areas. Hydraulic dynamometers of the telescoping prop variety and the flat cell type have been found useful. For closure observations a dependable recorder is on the market which can be supplemented with simple telescopic convergence rods for large-scale studies. These rods are particularly useful where rapid closure is occurring and frequent readings are being taken. In

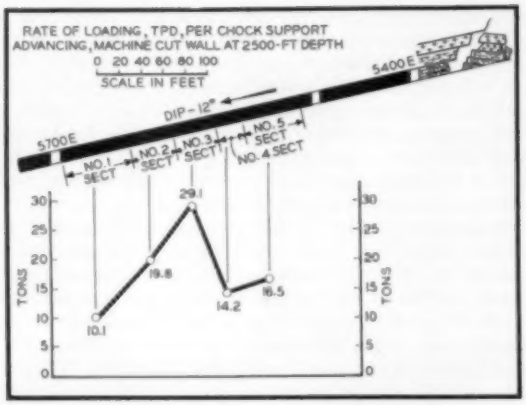

Fig. 3—Side view of longwall face in Springhill No. 6 mine, with rates of loading.

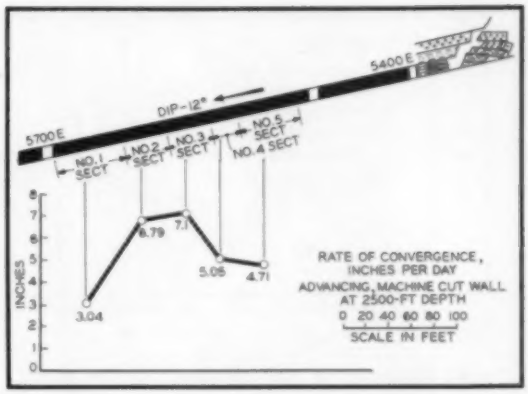

Fig. 4—Side view of longwall face in Springhill No. 6 mine, with graph showing observed rates of closure.

longwall operations the units are usually installed not only along the extraction face, but also in the levels servicing these walls. In a pillar extraction the instruments are deployed in grid fashion in rooms and levels ahead of the extraction line. As may be expected, underground conditions often prevent placing such apparatus in the most desirable positions. Also, the operations being studied may later be changed to an extent that will nullify or impair the value of the observations.

Fig. 1 is the side view of a longwall face in the Springhill No. 2 mine, with a graph showing rate of loading on the artificial supports in different sections of the face. It will be noted that the maximum values occurred approximately 100 ft above the lower end of the wall. Fig. 2 is the same side view illustrating the observed rates of closure in these same sections. Fig. 3 is a side view of a longwall face in the No. 6 mine, with a graph showing rates of loading on the supports. Fig. 4 illustrates the rates of closure in these same sections along the face. It is interesting to observe that in both mines the highest rate of support loading and the highest rate of convergence occurred in approximately the same position on the working face.

Conceivably the dominant common factor that would bring about such a similar result under widely different operating conditions is significant similarity in the strength of the rocks enclosing both seams. If rocks are not too dissimilar in characteristics they can be expected to fail in somewhat the same way in extracted areas and to set up a recognizably similar pattern of stress in the coal bordering the goaves. Since the total pitch length of the coal block in each mine was approximately the same, about 350 ft, it is also interesting to note that the distance from the edge of the older goaf (which lies on the rise side of the block) to the zone of maximum stress is nearly the same in each case. This distance may indicate the position of an abutment zone set up through the combined influence of the older goaf above and the new void being created by current extraction. The point of particular interest is that the increased depth apparently did not significantly modify the position of maximum loading on the exposed edge of a massive coal block. Of some significance also is the proximity of such an active zone to the level leading to the foot of the upper wall in No. 2 colliery, where three walls are operated in line. It is in this uppermost haulage level that almost all bumps in the active workings occur.

A striking parallel to this observed pattern of stress on long extraction faces in Springhill is reported[1] in the Champion Reef mine of the Kolar gold fields where a modified form of rill stope is employed with advance along the strike. It is reported that crushing of the upper portion of the block being mined will throw the pressure of the enclosing rock walls onto the bottom of the stope, which may then build up a tremendous amount of strain energy before failing.

Although such face observations were undertaken primarily to study ground behavior along the perimeter of massive coal blocks, the data also indicate the effects produced by individual mining operations at the coal face. Fig 5 illustrates the development of total convergence and the growth of support loading in No. 2 mine. It will be observed that convergence increases in a fairly linear fashion and indentations in the curve are due to decreased rate during shifts not producing coal. It is apparent that convergence proceeds in unison with coal removal and is promptly retarded when production ceases. Examination of the curve depicting growth of support load shows a reasonably linear relationship up to about 30 tons. Thereafter the rate of loading decreases. This lowered rate is considered due to yielding of the supports and floor rock rather than to a decrease of load.

Similarly, the results of face observations in the shallower No. 6 mine are illustrated in Fig 6. It will be observed that convergence proceeds in a generally linear fashion between the coal face and the caving line, with appreciably increased rates occurring during the coal loading shifts. The loading curve is reasonably linear up to a load of 50 tons and thereafter decreases.

Further reference to Figs. 5 and 6 reveals that the conditions observed in No. 6 mine, working at a depth of 2500 ft, were more severe than those observed in No. 2 at about 4000 ft of cover. It is therefore evident that under Springhill conditions depth is not a controlling factor in establishing the rate of closure and support loading on a longwall face. It would appear that a more significant factor is the type of face operations. In regard to speed of advance, the shallower, machine-cut wall advanced 6 ft per day while the deeper, hand-pick face advanced about 4 ft. On the basis of convergence per foot of daily advance the machine cut wall converged, on the average, 0.75 in. per ft of advance; the corresponding figure for the deeper operation

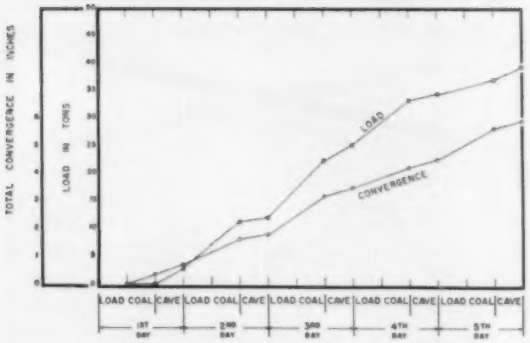

Fig. 5—Development of total convergence and the growth of support loading in No. 2 mine.

was 0.3 in. It is useful to compare such values with those obtained by Schwartz[3] in French mines for longwall operations using metal props and by N. S. Stephenson and S. Lewis[4] in United Kingdom collieries. Schwartz reports a daily convergence of 0.44 in. per ft of daily advance; a value of 0.62 in. was obtained by Stephenson and Lewis. These were for *non-bumping* mines and represented reasonably good face conditions.

The above observations at Springhill indicate that the loads effectively borne by the face supports can be imposed by the first 20 ft or so of strata immediately above the seam. It is therefore apparent that the bulk of the strata loading above the working area must be borne by the rock beds at no great distance from the seam. Their ability to perform this function depends on the care taken to preserve their strength, particularly when mining operations of undercutting and shooting are employed, as these can seriously deteriorate face conditions by weakening nearby rock beds. A speedy installation of adequate face supports under newly exposed roof can appreciably preserve the self-sustaining nature of the immediate strata.

Observations in the levels servicing such longwalls seek to determine the pattern of ground loading along these exposed edges of the large coal blocks being mined. It is hoped that these fringe studies in the *open*, in conjunction with observations made at the extraction faces, will clarify and support information obtained with borehole instruments in the *solid*. Elevation surveys were originally employed to differentiate between roof and floor movements, but results were not accurate enough to warrant continuing with this method, chiefly because there is no dependable base station within reasonable distance of the observation points. In the pitching seams of western Canada it was found impossible to attain acceptable accuracy in the inclined workings. In these western mines some trials were made with water-level devices in pitching rooms, but the long lengths of flexible tubing required were cumbersome and liable to damage in the coal chutes. Insofar as strata movements are concerned, therefore, much dependence is being placed on total convergence measurements, as these are direct measurements and quite reliable if taken carefully. In the case of the Springhill mines all evidence to date indicates that most of the convergence in roadways is due to floor lift.

Fig. 7 illustrates the closure observed at typical roadway stations plotted against distance to the wall face. For comparison, two samples are given of convergence observed in a Pennsylvania mine[4] and in a longwall operation in France.[5] These mines, particularly the Pennsylvania mine at 600 ft of cover, are substantially shallower than those at Springhill. The much greater amount and rate of convergences and distance affected in the Springhill roadways may be typical not only of coal mines operating under exceptionally deep cover but particularly of those possessing competent enclosing strata.

Reference to Fig. 7 will also reveal that two of these typical Springhill stations were chosen from among those with relatively narrow spans of gob (300 and 500 ft) while the other two were selected from those with wider spans (1500 and 1800 ft). There is no great difference between the 500, 1500, and 1800-ft spans, indicating that at Springhill the rate of closure on the levels does not progressively increase with growth of gob spans. Further information from continuing studies may possibly reveal that beginning at very short spans of 100 to 200 ft, there is a pattern of increasing convergence with increasing span up to a certain maximum width of gob and that thereafter the relationship does not change materially.

Fig. 8 illustrates the closure, with time, at a roadside station that was very close to two destructive bumps occurring within 16 days of each other. The decreased rate of convergence in the period preceding these bumps may indicate a temporary decrease in ground stress at this point or, equally, the existence in this part of the roadway of strong pavement strata more resistant to yielding under increasing load and thereby able to store energy and release it violently. Because of the marked heterogeneity of rock beds it is conceivable that such stronger zones can exist in the roadways, perhaps at irregular intervals, and serve as potential *loci* for bumps. More extensive study of the behavior of floor rocks in roadways is certainly warranted.

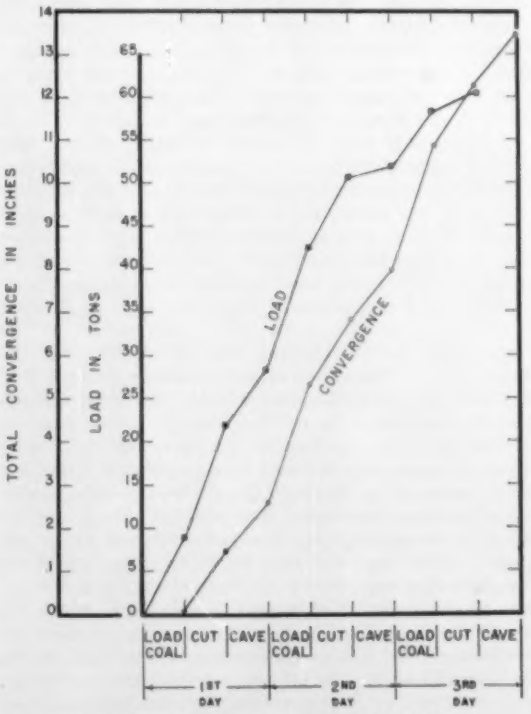

Fig. 6—Results of face observations in No. 6 mine.

Of the mines observed in western Canada only two—in Coleman, Alberta—will be considered. The McGillivray mine operates in a 9-ft coal seam at 2000 ft and the International mine operates in this seam at 2400 ft, at a point where the coal averages 17 ft thick. The McGillivray mine is subject to severe bumps; there have never been any occurrences in the International mine. The strata enclosing both mines are, on the whole, massive and competent, but in International the rock beds in immediate contact with the seam are relatively weak shales, whereas in McGillivray mine the rocks in immediate contact are more competent sandy shales, sandstones, and conglomerates. Although many faults intersect both workings, the strata are more severely folded in the McGillivray area, pinching out the seam in some locations and causing variations of 30° to 60° in the dip. With some local changes, usually at faults, the pitch in the International mine is fairly uniform at 30°.

Both mines use pillar extraction on the retreat. The practice is to drive a two-place level entry from the main haulage slope for several thousand feet along the strike to a predetermined boundary. Rooms are then driven up pitch to an older level above to begin pillar development at the inside end. Pillar extraction follows closely on pillar development and the two operations retreat toward the main slope. The panel of coal under exploitation extends the full length of the level entry and 400 ft along the pitch. To the rise side of this panel the totally extracted area extends for several thousands of feet towards the outcrop. Although there are some variations in size of pillars in each mine, those in International are approximately 85-ft square blocks and in the McGillivray mine 85 ft on the strike and 50 ft on the pitch.

In the thicker seam of International mine all development work is done in the top 7 ft of coal; the full height of the seam is subsequently mined at the pillar extraction line. In the McGillivray mine development work proceeds in the full thickness of the seam.

Bumps in the McGillivray mine have occurred on the pillar extraction line and also for distances up to 200 ft ahead, where they are usually associated with pillar splitting operations. Although International mine has never been affected by bumps, there is a slow but heavy extrusion of the bottom 10 ft of coal into the rooms and crosscuts that frequently closes them completely and necessitates re-driving. This extrusion is observable for several hundred feet ahead of the pillar extraction line.

Fig. 9 illustrates the closures observed on level roadways servicing the extraction lines in these two collieries. To complete the comparison an equivalent record is included for a roadway leading to a retreating longwall in No. 2 mine at Springhill. This figure shows the closure that occurred during a 500-ft advance of each of these three extraction faces. At the end of this advance, the extraction lines had arrived at the observation points. The horizontal axis of the graph indicates the length of time required to advance each extraction line the 500 ft. This method of comparing results over a long period and for a large advance was adopted because of the very irregular nature of the pillar extraction lines and the virtual impossibility of deciding, from pillar plans, just what the true shape and successive positions of the pillar line were during short intervals. All three operations progressed at normal

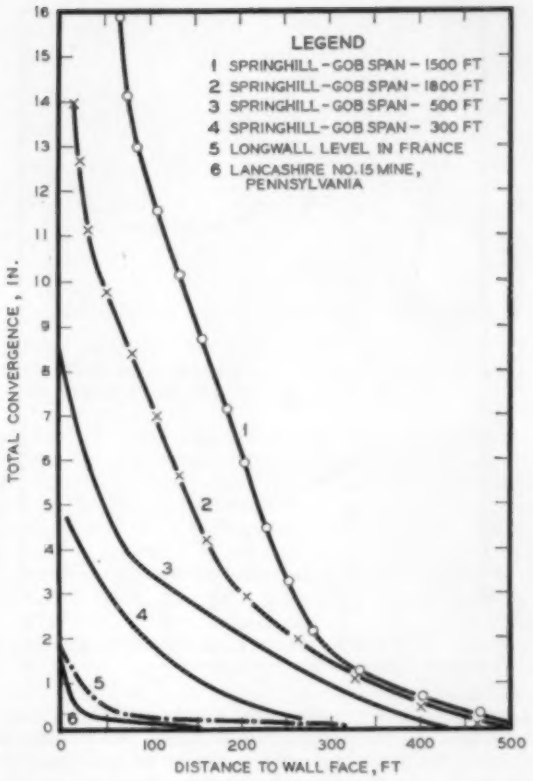

Fig. 7—Closure observed at typical roadway stations plotted against distance to wall face.

speed during their selected periods, but the effect of an annual holiday period at Springhill is revealed by a flattening graph about 50 days before the end of these observations.

The rigidity of ground in McGillivray mine is apparent from this record, especially in comparison with the adjoining International. It is reasonable to assume from the ground behavior observable in both mines that the freedom from bumps in International operations, under the same massive cover as its immediately adjacent neighbor, is due to the more yielding characteristics of the seam and its immediate roof and floor rocks. Such strata cannot, apparently, store up enough strain energy for violent release. However, it should not be inferred that the seam in the McGillivray is a strong coal capable of large resistance to converging rock walls, for it is quite characteristic of the sheared and friable coals of the Rocky Mt. region. It is not, for instance, as strong a coal as that of Springhill. Nevertheless, it will be observed from Fig. 9 that closure at McGillivray is markedly less than in Springhill. The answer must lie in the greater strength of the McGillivray rock beds, which are able to sustain long spans across yielding pillars and totally excavated areas. It is suggested, therefore, that in the pillar development area ahead of the McGillivray extraction line, the roof and floor strata may already be largely self-supporting but converging slowly enough, as indicated in Fig. 9, to maintain the enclosed pillars in a high state of stress for applicable periods before crushing. Experience at the mine indicates that pillars directly on or adjacent to the pillar extraction line are still highly stressed and

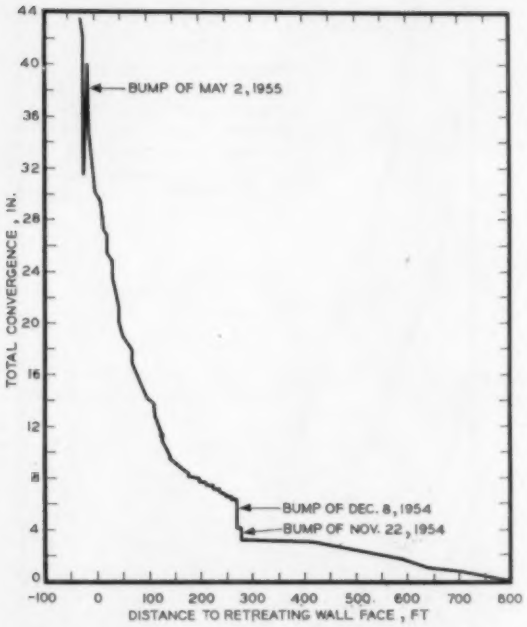

Fig. 8—Closure, with time, at a roadside station close to two bumps occurring within 17-day period.

generally can be mined safely only by taking successive slices off the destressed edges. An improved practice based on this concept would be to encourage greater yield in pillars by making them originally of reduced size, thus lowering their capacity for storing strain energy. Similarly, large pillars already formed could be split well in advance of the extraction line and before they come under the influence of the forward abutment pressure zone.

Measurements in the Solid

Further significant understanding of the mechanics of ground failure depends on the application of all available knowledge of stress analysis and the degree to which this knowledge can be utilized when operations are dealing with such heterogenous and aeolotropic materials as mine rock, which exhibit both elastic and plastic deformations under stress. In such studies due consideration must be paid to the phenomena of time strain and the influence of constraint on the behavior of rocks under stress. In this direction of continuing exploration into the largely unknown field of ground mechanics, it is encouraging that very substantial progress has been made during the last quarter-century in the allied field of soil mechanics. As an outgrowth of current studies at the Mines Branch, a beginning has been made in developing apparatus to observe stress changes *within the solid*, in the hope of gathering basic data related to stress conditions remote from open workings. To date, fairly extensive field tests have been conducted with a borehole load cell incorporating electric resistance strain gages, an electrical resistivity device, and ultrasonic apparatus. The load cell has been tested in both coal and metal mines, but the resistivity device was specifically designed for coal mines subject to gas outbursts and the ultrasonic equipment was designed for metal mines. For the sake of brevity only load cells will be discussed here.

With regard to borehole cells in general, it was initially considered that valuable preliminary information might be obtained by employing a simple hydraulic type as a scouting device pending development of a more precise unit. Consequently a number of hydraulic cells, molded from rubber, 3 ft long and 1½-in. diam, were installed inside boreholes drilled 50 ft deep into large coal blocks in the Coleman mines. The cells were grouted in with a mixture of coal dust and gypsum cement, then raised to initial pressures of 60 to 75 psi. Observations were continued for more than a year and until the pillar extraction line had reached the cells. Fig. 10 is a graph of the pressures observed with one cell as the extraction line progressed more than 1100 ft to meet it. Although it would be inadvisable to interpret much from this record, it does indicate that mining-induced stresses are detectable inside large coal pillars at appreciable distances ahead of an extraction line and that pressure on the embedded cell kept increasing as the extraction approached. Pending further trials with hydraulic units of improved design no explanation will be attempted for sudden changes in observed pressures such as that indicated at 650-ft distance in Fig. 10. As a borehole unit this simple type of hydraulic cell can be used in highly deformable materials only, such as the mountain coals of western Canada and possibly the soft clays of the Prairie mines.

When the Mines Branch began development of more precise types of borehole load cells, it was decided that observations of stress in a single direction should be extended to include the two principal stresses and their orientation. Also, since the units were intended for underground mines, they must retain a satisfactory degree of accuracy and reliability over long periods. A further requirement is that any such device must comply with strict mines regulations regarding safety. The development of a device embodying all these requirements presents unique difficulties.

Initial attempts have been to develop a strain-gage load cell incorporating electric resistance strain gages bonded to a strain-sensitive member of known elastic constants. Such efforts have been adequately reported in earlier papers,[6-8] and only the essentials will be given here. The main component is a metallic load-bearing disk of 2-in. diam and 3/16 in. thick, as designed for anticipated ground stress conditions at Springhill, with a rectangular rosette electric resistance strain gage bonded to each face. This type of gage has three separate strain-measuring elements mounted in horizontal, vertical, and 45° positions.

Stress in the disk is calculated from the formulas:

$$\sigma_1 = \frac{E}{2(1-\mu)}(e_1 + e_3) + \frac{E}{2(1+\mu)}\sqrt{\left[2e_2 - (e_1 + e_3)\right]^2 + (e_1 - e_3)^2}$$

$$\sigma_2 = \frac{E}{2(1-\mu)}(e_1 + e_3) - \frac{E}{2(1+\mu)}\sqrt{\left[2e_2 - (e_1 + e_3)\right]^2 + (e_1 - e_3)^2}$$

$$\theta = 1/2 \tan^{-1}\left[\frac{2e_2 - (e_1 + e_3)}{e_1 - e_3}\right]$$

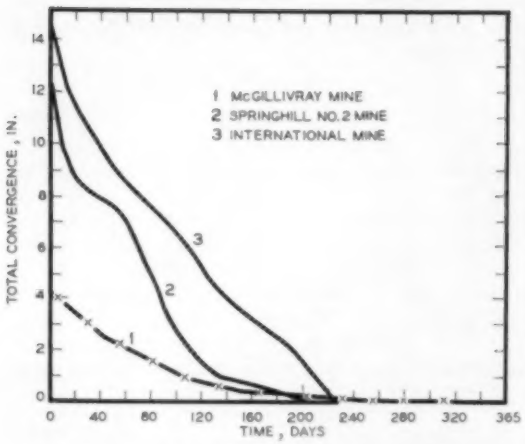

Fig. 9—Closures observed on level roadways servicing extraction lines at McGillivray and International mines. For comparison, a similar record is shown for roadway leading to retreating longwall in No. 2 mine at Springhill.

where σ_1 = maximum principal stress.
σ_2 = minimum principal stress.
θ = angle from direction of e_1 to σ_1.
e_1, e_2, e_3 = strains measured from rosette gages.
E = elastic modulus of disk material.
μ = Poisson's ratio of disk material.

In practice, the angle θ defining the direction of the maximum principal stress is expressed counterclockwise from the horizontal. Originally, the load-bearing disk was made of magnesium to take advantage of its low modulus of elasticity and thus obtain a high strain sensitivity to change in applied stress. Later, because of a possible sparking hazard associated with light alloys, the disk was made of steel but sufficiently decreased in section to retain enough sensitivity to changes in stress. In the earlier magnesium cell, the load-bearing disk was mounted inside a thin-walled cylindrical steel shell, but the later steel models were machined out of solid stock so that the disk became an integral part of the outer shell. The cylindrical shell has tightly fitted end caps to help exclude moisture and dust. Other essential components are a dummy gage for compensation of apparent strain due to temperature changes and a leveling device for proper orientation of the rosette grid at the back of the boreholes. Ancillary apparatus includes special inserting rods and a plunger device for depositing at the back of the borehole the desired quantity of grouting material, into which the cell is subsequently embedded. A five-conductor cable, usually in 50-ft lengths, is carefully connected on surface to the active and dummy gages and led out of the cell through a tight waterproofed gland. Readings may be taken with any satisfactory strain gage bridge, but because of the safety requirements in coal mines a specially designed low-current bridge, battery-operated, was constructed at the Mines Branch. Laboratory tests with this type of cell embedded in blocks of concrete and coal gave a repeatable relationship between load applied to the unconfined blocks and the observed stress changes in the disk. It will be readily appreciated, however, that the observed stress in such a metallic inclusion does not represent the magnitude of the stress in the enclosing medium, and while laboratory tests to date give some idea as to

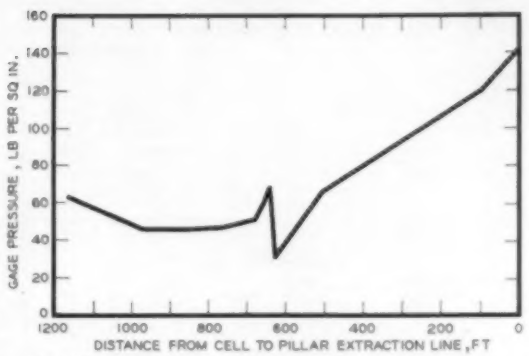

Fig. 10—Pressures observed with one cell as the extraction line progressed more than 1100 ft to meet it.

the ratio between the two under some specific conditions, much more testing remains to be done. To illustrate what has been observed at depth in the longwall workings at Springhill, Fig. 11 is the record of a cell over a three to four-month period as the wall face progressed from 380 ft to approximately 200 ft from the cell. This unit was installed in the coal 50 ft above the lower roadway in Fig. 1. As may be noted, the increase in stress in the cell is fairly gradual but proceeds in a series of jogs; this is quite typical of what has also been observed in the open workings during current and earlier[8] investigations. The principal stress is dilational and the shear stress is of small magnitude.

The shortcomings of the strain-gage load cell are caused to some extent by the rugged underground conditions under which it must be applied and by the problems of making strain gages stable over extended periods. Damage to cells has ranged from crushing of the cell bodies and straining of the load-bearing disk beyond the elastic limit—under what must be abnormally high stresses in the coal—to rupture of the electric cable by great extrusions of the coal seam toward the mine openings as the extraction face nears the installed cells. Another serious difficulty is encountered in drilling the required boreholes in highly stressed areas of the seam. In such areas, holes have readily been drilled into the coal for distances of 20 to 30 ft using light hand-held rotary drills, but immediately beyond these distances the holes collapse, jamming the rods and effectively preventing any further progress even with the heaviest drilling equipment available at the property. It is also considered that moisture has an important effect on the breakdown of cells despite very careful waterproofing. It is appreciated, of course, that this type of unit is essentially a strain-sensitive strut that indicates deformation of the borehole. In this respect its behavior is doubtful when the disk does not lie in the plane of applied stress. But even with these drawbacks, this type of borehole cell can provide useful data in underground observations.[7]

From theoretical considerations it can be shown that if the load cell has a modulus of elasticity at least three to four times greater than the surrounding media, then it is possible to relate changes of stress in the cell to those in the media. This method offers the advantage of not requiring an accurate knowledge of the modulus of the surrounding media.[10]

On the basis of this theory the Mines Branch is also developing an inclusion type of cell. Ideally

Table I. Mean Values of Elastic and Failure Characteristics for Some Canadian and European Mine Rocks under Uniaxial Stress at Room Temperature

Location	Rock Type	Aggregate Thickness Sampled, Ft	N	E_c	P_u	u	W	B	Type of Violent Stress Relief
Canmore, Alberta	Shale (slatey) †	Random samples	11	4.3×10^6	49×10^3	0.09	280*		Outbursts of gas and coal
	Shale (slatey) †		7	3.2	27	0.13	113*		
	Shale (slatey) †		3	5.5	55	0.13	275*		
Coleman, Alberta International mine	Shale	99	24	4.1	19	—	40	29	
	Sandy shale	42	32	5.0	22	—	56	30	None
	Sandstone	37	21	5.9	34	—	108	32	
	Conglomerate	45	10	4.9	26	—	72	28	
Coleman, Alberta McGillivray mine	Shale	108	33	3.9	15	0.09	14	25	
	Sandy shale	60	6	3.4	21	0.09	67	—	Bumps
	Sandstone	200	153	4.3	31	0.08	113	33	
	Conglomerate	4	5	3.6	32	—	167	30	
Cape Breton coal fields, Nova Scotia	Shale †	Random samples	2	1.8	11.3	0.22	36*		None
	Shale (clay) †		2	0.7	6.3	0.25	28*		
	Sandy shale		38	5.0	27.0	0.13	73*		
	Sandstone		13	1.8	8.5	0.48	23*		
Fernie, B. C. Elk River and Coal Creek mines	Shale †	240	12	5.6	25	—	56*		Bumps and outbursts of gas and coal
	Shale †		7	4.4	32	0.11	116*		
	Sandy shale	—	10	5.4	31	—	86*		
	Sandstone	85	35	6.0	25	—	52*		
	Conglomerate †		14	5.7	26	—	59*		
	Conglomerate †	61	1	4.8	37	0.12	142*		
Springhill, N. S. No. 4 mine	Shale	107	30	4.0	20	0.10	55*		
	Sandy shale	137	100	4.0	30	0.10	112*		Bumps
	Sandstone	64	105	4.5	25	0.10	69*		
Springhill, N. S. No. 2 mine	Shale	70	18	5.1	18	0.17	32*		
	Sandy shale	76	175	6.4	24	0.15	45*		Bumps
	Sandstone	46	110	4.6	22	0.11	53*		
Brodsworth, England Barnsley seam	Shale	Random samples	4	4.5	20	0.18	45*		None
Kilnhurst, England Parkgate seam	Sandstone	Random samples	12	2.7	16	0.20	47*		Bumps
Lorraine Collieries, France	Shale	Random samples	9	3.0	12	0.25	24*		
	Sandy shale		6	3.5	22	0.10	70*		
	Sandstone		5	1.2	6	0.35	15*		None
	Conglomerate †		4	2.0	9	0.34	20*		
	Conglomerate †		4	3.2	18	0.13	51*		
Neumehl, Germany	Sandstone †	Random samples	13	2.2	15.7	0.21	56*		Bumps
	Sandstone †		18	3.5	23.9	0.09	82*		

N = number of test specimens.
E_c = compression modulus, lbs/in.$^2 \times 10^6$.
P_u = ultimate compressive strength, lbs/in.$^2 \times 10^3$.
u = Poisson's ratio, dimensionless.
$W = \frac{1}{2} \frac{P_u^2}{E_c}$ strain energy at failure, in.-lbs/in.^{3}
B = fracture angle, degrees.

† Groups of the same material with appreciably different characteristics or obtained from a different location in the area.
* Values calculated from mean values of compression modulus and ultimate compressive strength as listed in table.

this cell should take the form of a solid cylindrical metal inclusion, but a compromise must be reached in the design, as there is the problem of measuring the stresses inside this inclusion. It is also desirable to be able to measure stress in an arbitrary direction. This requirement is met by splitting the metal cylinder along the axis and sandwiching between these two halves a thin metal flat-jack filled with oil. The stresses exerted on this oil are recovered by a diaphragm type of recorder using electrical resistance strain gages. Work along much the same lines is being conducted in the United Kingdom. With this method it is essential to use the minimum volume of oil in order to maintain the effective elasticity of the load cell at a high enough level. It is also proposed to locate the diaphragm recorder in the roadway, so that if the electrical strain gage fails it can be replaced with minimum loss of readings.

In conjunction with the development of this cell, another type of cell is being developed to measure the magnitude and direction of two principal stresses. For this it is proposed to use a thick-walled steel tube. It is hoped to measure the stresses in this tube by an air-gaging technique that has many interesting possibilities for coal mines, where the use of electrical apparatus is so restricted.

With both these cells it is desirable, during installation, to pre-stress them as nearly as possible to the stress conditions of the enclosing media. An installation method for attaining the required stress level is being developed.

Seismological Observations

In collaboration with the Seismological Division of the Dominion Observatory,[11] there has also been considerable effort to learn whether or not minor earthquakes are occurring in the coal fields under study in eastern and western Canada and whether any such manifestations of regional geological activity are associated with mine bumps. These studies are also intended to supply a better record of the bumps occurring in each field, many of which are not noticeable and hence not reported by the mines concerned. Continuous recording of such events would make it possible to relate their incidence more closely to the mining operations.

For initial exploration of the problem two seismographs were installed in the coal mining centers at Fernie and Coleman in the Crowsnest Pass coal field of western Canada. A third was installed in the prairie region at Turner Valley, well distant from any mining operations. Earthquakes were recorded at all three stations and, in addition, many small disturbances were recorded at the mine sites, especially at the Coal Creek collieries of Fernie. A closer network of radio-linked seismographs was then installed in the Fernie area. The records of these seismographs established that the small disturbances were occurring in the mine workings. Later, in eastern Canada, a single seismograph was installed in the Springhill coal field to record the tremors occurring in the area and to study their association with the mining operations.

To summarize very briefly the findings of this study, there seems to be no correlation between earthquakes and bumps. Following an earthquake tremor the number of recorded bumps did not increase. There does appear to be a definite relation between the rate of mining activities and the frequency of local tremors, since it was observed—both in the East and in the West—that cessation of mining operations, even for a weekend, substantially reduces the number of tremors recorded. This would also indicate that the ground tremors observed are principally caused by strata readjustments associated with the current working faces and much less by long-term ground stress relief in older extracted areas of the underground workings.

Rock Mechanics

Complete understanding of the action of stress on a material necessitates laboratory investigation into the elastic and failure properties of that material. Investigations are being conducted along three distinct but related paths, namely, short-period uniaxial compression, long-period uniaxial compression (time-strain), and triaxial compression.

Studies have been carried out to determine a number of the elastic and failure properties of mine rock under short-period uniaxial compression, including the following: compression modulus, Poisson's ratio, ultimate compressive strength, strain energy at failure, and fracture angle.

These tests were conducted on right cylindrical specimens prepared from diamond drill cores varying from ⅞ to ⅛-in. diam. Longitudinal and transverse stress-strain relationships were obtained for stress increments of 1000 psi up to a maximum stress of 20,000 psi, and from such data the tangent values of compression modulus and Poisson's ratio at 6000 psi were obtained by graphical means. Each specimen was then loaded at a constant stress rate of 200 psi per sec until failure took place, and ultimate compressive strength, strain energy at failure, and fracture angle were determined.

Table I illustrates some results of tests carried out on specimens obtained from a number of Canadian mines. These results indicate the wide variation in elastic and failure properties between individual rock types and between similar rock types obtained from different mines. For comparison, results obtained from tests at the Fuels Division on a number of European mine rocks are also included. From the limited number of tests conducted so far, it would appear that rocks obtained from mines with a history of violent stress relief have a higher ultimate compressive strength and are capable of releasing more stress energy at failure than those obtained from mines not so affected.

Tests on the rocks from Springhill No. 2 mine do not support the view that a particular type of rock or individual bed is significantly stronger than the rest and therefore a possible single cause of bumps. It would appear rather that all rock beds in Springhill are quite competent.

It was recognized from the outset that the influence of time on the elastic and failure properties of mine rock must also be investigated. It was also appreciated that—as compared to short-period uniaxial compression testing—a study of time-dependent properties would be more difficult, necessitating the design of special apparatus and technique. Development in this direction has been carried out

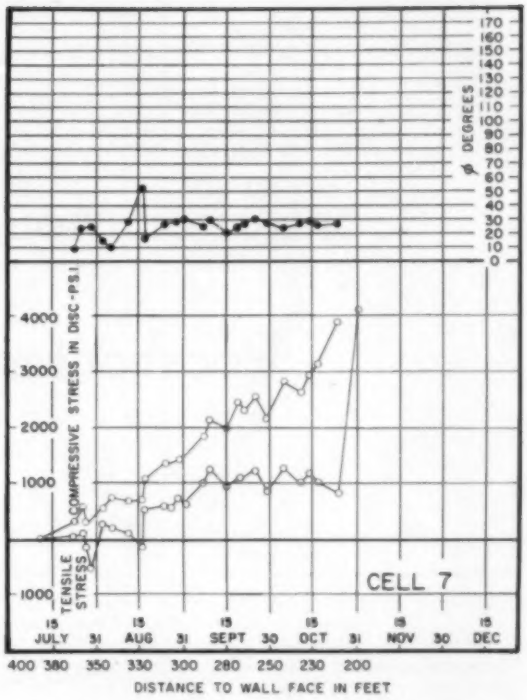

Fig. 11—Record of cell over period of several months as wall face progressed from 380 ft to about 200 ft from cell.

during the last two years, and a time-strain apparatus is now being completed in which the time-dependent characteristics of three separate specimens may be studied simultaneously at loads up to 25,000 lb.

The third stage of study into the physical properties of mine rocks necessitates investigation into the behavior of these materials under conditions of triaxial stress. A few initial experiments have already been conducted, principally to secure information required for design of apparatus. A triaxial stressing unit is now being constructed at the Mines Branch. When it is completed a program of triaxial testing will be initiated.

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Control of Mountain Bumps in the Pocahontas No. 4 Seam

by Woods G. Talman and John L. Schroder, Jr.

EXPERIENCE has shown that certain known natural conditions and other indefinite characteristics combine to make a mining area vulnerable to mountain bumps. Some of the known conditions are heavy overburden, an overlying stratum of strong non-elastic rock, a structurally strong coal seam that does not crush easily and yet is the weakest stratum in the series, and a floor stratum of more than ordinary firmness.

The indefinite characteristics could include resistance of top or bottom of a coal seam to lateral flow, effect of immediate top and bottom strata, nature of the coal seam, and other factors about which very little is known. It is in this area that exhaustive study is needed to achieve positive control of the dreaded mountain bump hazard.

In the Gary district, West Virginia, two of the five operating mines have areas known to be vulnerable to mountain bumps.These are the No. 2 and 6 mines, which are working the Pocahontas No. 4 coal seam. In this area the seam is overlain at a zero to 10-ft interval by the massive Eckman sandstone, which is about 100 ft thick in the vulnerable areas. Total overburden, consisting of shale, coal seams, and sandstones, ranges from 700 to 1400 ft where bumps have occurred (Fig. 1). The coal seam is 4 to 8 ft thick and has a weak columnar structure of very soft and spongy or *woody* coal. The immediate top is either the Eckman sandstone or hard shale, both of which provide generally good roof conditions for mining operations. The bottom ranges from medium to hard gray shale.

The incidence of bumps in the Gary district dates from about 1930 and can be correlated to some degree with the increased rate of extraction attained with mechanical mining. During early years of operation at the No. 2 and 6 mines, most of the work was development and under comparatively light cover. As overburden became heavier, together with an increasing percentage of coal coming from pillar extraction, mountain bumps began to occur. Before 1945 they were much less severe than in later years, and because there were no injuries or fatalities, no records were kept. But by 1951 the incidence of bumps had increased to such extent that it became evident a mining system would have to be designed to eliminate or at least minimize these occurrences.

Drawing on experience with modified versions of old systems and certain characteristics peculiar to the Pocahontas No. 4 coal seam, the district mining engineer, Martin Hayduk, outlined the essential factors for bump control in the Gary district. These control factors indicated:

1) The highly stressed area, which lies within the limits of convergence effects, moves at approximately the same rate as the retreating pillar line.

2) There is a decided softening of the periphery of blocks which is greatest and deepest on the gob side.

3) Blocks less than 45 ft wide never have been known to bump in the Pocahontas seams.

Fig. 2 shows the mining plan based on these observations—a thin-pillar system with a minimum of secondary development.

It was recognized from the start that the Hayduk system had certain limitations. When pillar work backed up to an inevitable surrounded block it was no longer applicable; also, *burnt* bottom and/or unknown factors reduced the system's effectiveness in certain headings.

Since there was no way to eliminate the loaded block, it was decided to experiment with auger drilling to attain controlled release of this stored-up energy. The decision to auger was made after consideration of three separate plants, which were:

1) To cut the solid block into pillars of maximum size by driving away from the fracture line and at such a distance outby that development

W. G. TALMAN, Member AIME, is Assistant Vice President, Coal Staff, U. S. Steel Corp., Coal Div., Pittsburgh, Pa., and J. L. SCHRODER, JR., is Acting General Superintendent, Lynch District, Lynch, Ky.

TP 4771F. Manuscript, April 21, 1958. New York Meeting, February 1958.

would be active only in the area outside the abutment zone.

2) To induce a bump in the large block by blasting.

3) To drill enough holes through the large reserve blocks to effect a gradual crushing action, or induce a series of light bumps to release the stored energy.

Plan 1 was tried with only moderate success—bumps were minor, but still serious—and this approach was discontinued. Plan 2 was not tried because of the obvious safety hazard and violation of State and Federal regulations. Plan 3, adopted as an experiment in August 1953, proved three main criteria:

1) Coal pillars known to be heavily stressed can be drilled successfully.

2) Without jeopardizing the workmen's safety, mountain bumps can be triggered by drilling into loaded pillars.

3) Loaded pillars can be stress-relieved by drilling large-diameter holes with underground auger units. The pillars remaining can be mined normally without danger of reloading and bumping and also without so much pre-weakening that a general squeeze is induced.

Experience in the drilling program since 1953 has led to spotting holes opposite break-throughs, using two rows of cribs to protect the workmen and rig. There are lagging boards across one row of cribs. The details of a bump and the effectiveness of the barricade are shown in Fig. 3. If precautions had not been taken to crib and board between the mouth of the hole and the rig, the workmen would have suffered serious injuries or worse.

On the basis of drilling experience to date, *thumb rules* have been established to guide plans for probing or stress-relieving vulnerable blocks in the Pocahontas No. 4 seam:

1) Pre-weakening holes must be projected on room centers.

2) After a hole is drilled, room development is to follow the auger hole regardless of the direction it takes.

3) The drill rig shall not be positioned less than 35 ft from the mouth of the hole being drilled.

4) Drilling and section mining operations shall not be conducted on the same shift.

5) A section loading operation shall not be conducted less than two blocks away from a vulnerable block while augering is in progress.

6) Mine development shall stop 35 ft outby end of auger holes in cases where all stresses have not been released. With proper protection and specified distance from face, the hole may be extended.

7) No rooms or openings are to be driven without a protection hole on the vulnerable side.

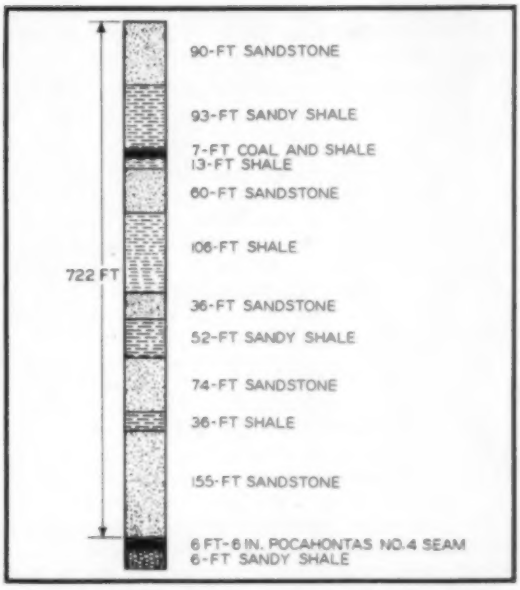


Fig. 1—Typical stratigraphic section overlying Pocahontas No. 4 seam. Cover ranges from 700 to 1400 ft.

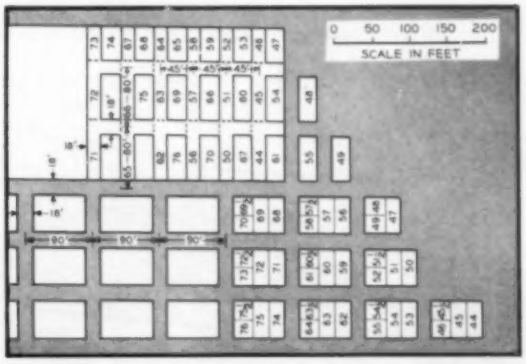


Fig. 2—Typical mining sequence utilizing the thin-pillar system.

8) When there is any doubt as to whether a hole has been closed by subsidence and/or bumps, it must be re-drilled before it is used as a protection hole.

9) It must be verified that auger holes have cut through bottom bone and coal to the mine floor.

10) There must be as few men as possible at the face at all times.

Figs. 4-8 show an actual drilling and mining sequence for stress-relieving one of the large blocks in No. 2 mine. During the course of the job there was a heavy bump, from which additional knowledge was gained.

Investigation of the bump shown in Fig. 7 resulted in the following conclusions:

1) Previous augering experience indicated stresses had been relieved in the area so that room advance and a break-through to room 2 could be accomplished with no difficulty.

2) The approved augering plan and subsequent room development were being carried out by mine management and workmen in exact detail.

3) The room advanced in a highly stressed area, resulting in a bump of medium intensity that was unpredictable.

A Joy crawler-mounted underground auger unit (Model AD-10) was received Aug. 15, 1957, complete with accessories and features custom-built to the specifications derived from two years of experimental work. This unit incorporates caterpillar mounting, dual controls, instantaneous reverse, integral roof jacks, two winches, 12-in. and 24-in. auger sections, a separate portable elevating conveyor, and various safety features. Face equipment receives power through a circuit breaker at the power source. This breaker is arranged so that a ground in the auger circuit or a severe overload—such as that caused by a bump stalling the auger—will trip it and remove power from the entire section.

A 25,000-cp, six-cell spotlight now facilitates inspection of auger holes, minimizing the danger in performing this important phase of the job.

Since 1953 several improvements in the drilling program have resulted from modifying the equipment and procedures. To help prevent fouling of the auger in light bumps and to control auger drift, Roy Parsons, mine foreman, designed an auger protective device. The first unit (core barrel) was made of ⅜-in. steel sheeting with 10-in. perforations. The diameter was 26 in., and the 7-ft length encased the first auger section and three-quarters of the second section. Since the 10-in. perforations of the initial design did not admit large lumps of coal, these openings were enlarged. Another improvement was shortening the unit to 4 ft. This permitted the device to follow sudden grade changes, whereas the 7-ft length did not.

The diameter of the new device has been reduced to 24 in. and the auger section in the barrel trimmed to fit. Originally the diameter was 2 in. larger than that of the outby augers, and when the hole outby the barrel closed to the minimum 24 in. it was difficult to retrieve the barrel after the hole was completed.

After three years of drilling in vulnerable blocks, much has been learned about the type of auger section used. The standard auger is 4 ft long, 24 in. diam, and 24 in. between ribbons with a 45° pitch. Spacing of ribbons and degree of pitch have been improved by using auger sections with ribbons 8 in. apart. Five augers—20 ft of this type of section—are used immediately behind the protective device or barrel. These closer-spaced augers perform two major functions:

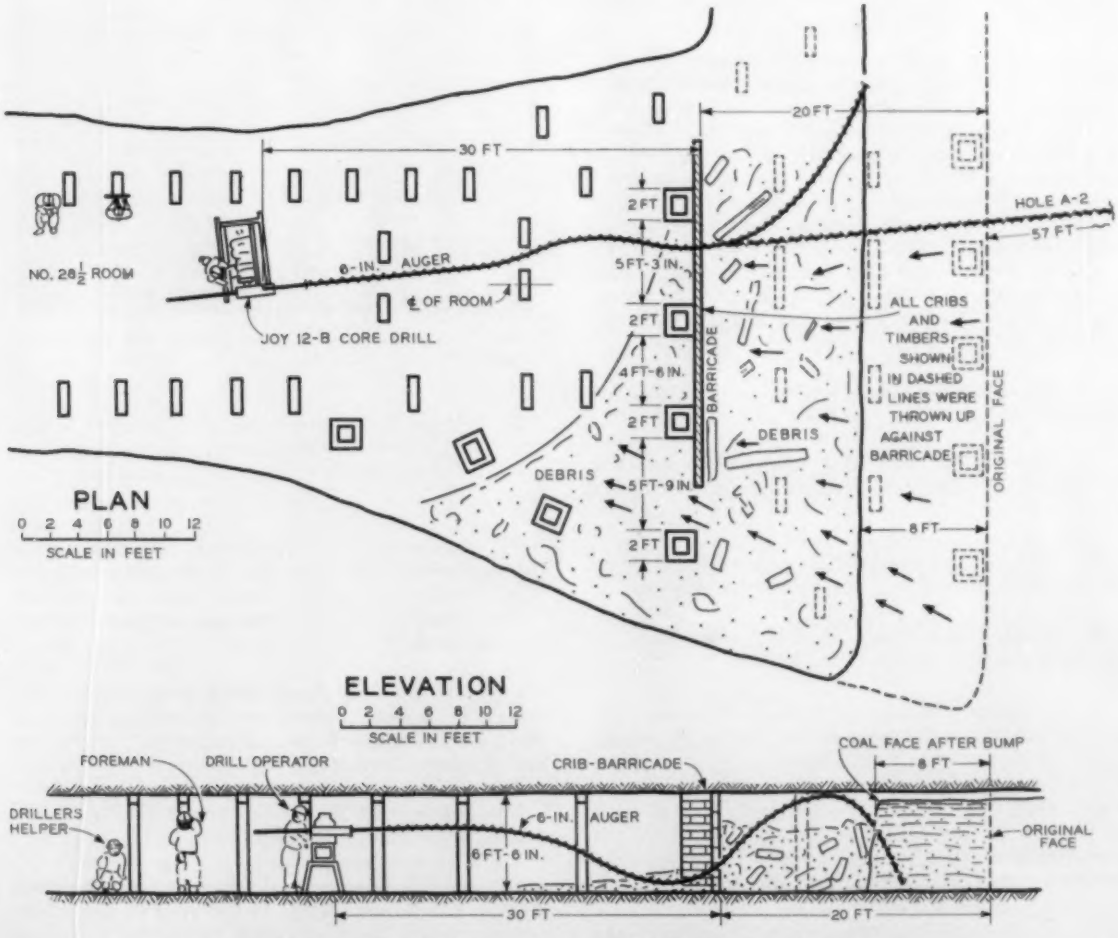
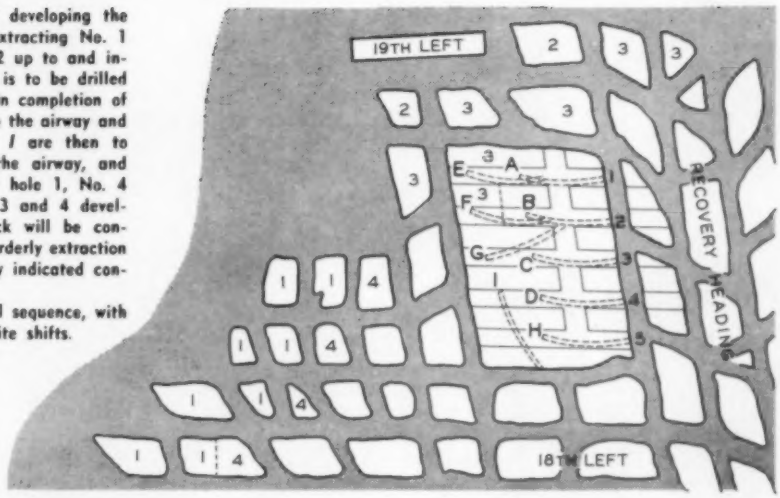


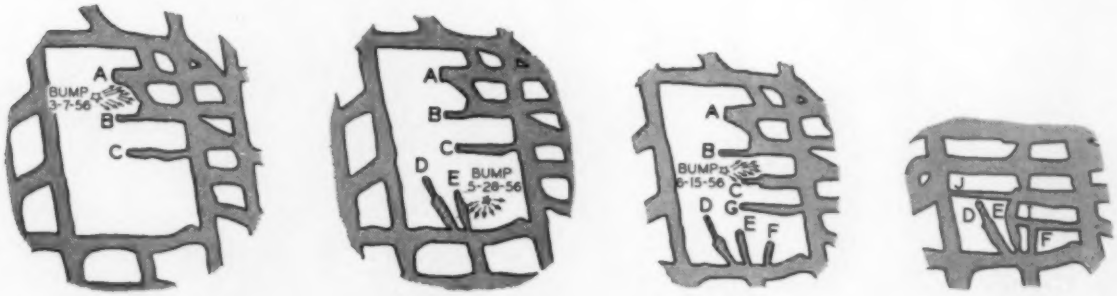
Fig. 3—Details of a bump in Pocahontas No. 4 seam and effectiveness of safety measures.

Fig. 4—Original plan for drilling and developing the block: Drill holes *A*, *B*, and *C* while extracting No. 1 pillars and then develop rooms 1 and 2 up to and including the first break-through. Hole *D* is to be drilled along with holes *F* and *G* in room 2. On completion of hole *G*, room 1 is to be cut through into the airway and No. 2 pillars extracted. Holes *H* and *I* are then to be drilled, room 2 cut through into the airway, and No. 3 pillars mined. On completion of hole 1, No. 4 pillars are to be extracted and rooms 3 and 4 developed through, at which point the block will be considered sufficiently developed to permit orderly extraction of pillars to a line to be established by indicated conditions as the pillar line moves outby.

Holes are to be drilled in alphabetical sequence, with drilling and mining conducted on opposite shifts.



Figs. 5-8 (below)—FIRST: Shows progress on the large block with a revision to the original plan dictated by initial results with drilling and mining. Holes *A*, *B*, and *C* were drilled to their projected depths only after light medium bumps had continuously interrupted drilling operations by fouling and damaging the augers. Most of this trouble was attributed to light bumps and right-hand rotation of the drill, which caused sections to operate on curve alignment. SECOND: It was evident that the major stress in the block was not relieved by inby drilling and that further activity on that end of the block might cause a major bump, with injury to workmen. It was decided to try to activate a major bump by drilling from the outby end of the block. Hole *D* was drilled to the projected depth, and hole *E* set off a bump at 55 ft. THIRD: After hole *E* had induced a major bump, hole *F* was drilled only to reduce the size of the corner block. Hole *G* was drilled to ascertain remaining pressure. Since no pressure was found in hole *G*, loading operations were activated in the room following hole *C*, which had been drilled to a depth of 75 ft. Beginning at the mouth, loading operations had advanced 52 ft, or within 23 ft of the end of the hole, when a medium bump occurred. FOURTH: Here the vulnerable block is shown completely relieved of stress. Holes *I* and *J* were drilled in proper sequence as protection holes from room development.



1) In the event of a bump, they limit the load on the outby augers so that the entire string is not completely loaded. This helps prevent fouling of the augers.

2) Owing to the steeper pitch of the 8-in. spacing between ribbons, the augers tend to stay on the bottom instead of riding up on top of the bottom bone as the 24-in. spaced ribbons do.

Originally the auger sections were held together with ¾-in. pins slipped into ¾-in. holes. This did not prove entirely satisfactory, as occasionally the pins slipped out and it was difficult to retrieve the augers. The problem was solved by enlarging the holes to 1 in. and using a 1-in. steel bolt. No augers have been lost since the change-over.

The major problem of keeping the auger on the bottom has been solved by establishing a drilling rate of approximately 10 in. per min.

Bits on the earlier cutting head were welded directly to the frame. This assembly has been improved by lugs on the cutting head, for faster bit changes.

Summary

In the course of drilling operations over the past four years, there has been considerable progress in controlling bumps in the Pocahontas No. 4 seam. This has been achieved by a trial and error approach to a safe and workable drilling plan, careful analysis of all bumps, and consultation with roof control specialists. Because men's lives are involved, many experiments have been restricted, and it has been necessary to find answers to the problem via the negative approach of "things not to be done in vulnerable areas."

The U. S. Bureau of Mines has initiated a program for exhaustive study of this subject and is now collecting field data. Part of the analysis involves correlating all experiences and data available from the various companies affected, and this alone will provide some interesting and helpful observations.

Discussion of this article sent (2 copies) to AIME before Sept. 30, 1958, will be published in MINING ENGINEERING.

Discussion

Fine Grinding at Supercritical Speeds

by R. T. Hukki

(MINING ENGINEERING, page 581, May 1958, AIME Trans., vol. 211)

John F. Myers *(Consulting Engineer, Greenwich, Conn.)*—Since the art of comminution has lain practically dormant for many years, it is very interesting that R. T. Hukki approaches the subject with a new concept.

One is reminded of the research carried on by A. W. Fahrenwald of Moscow, Idaho, a few years ago. Fahrenwald mounted a steel bowl on a vertical shaft. The balls and ore placed in the bowl were rotated at fast speeds, thus simulating the supercritical speeds used by Hukki. The rolling action of the balls against the smooth shell liner has pretty much the same effect. The action is horizontal in one case and vertical in the other. Both researchers report good grinding activity.

It is also constructive that such able investigators give to the students of comminution their interpretation of their laboratory results in terms of large-scale operation. History shows that it takes a lot of time for such radically new ideas to be absorbed by the industry. Typical of this is the present-day activity of cyclone classification in primary grinding circuits. The idea of cyclone classification has been kicking around for 30 or 40 years.

Certainly we all suspect that the ponderous grinding mills of today, and their accessory apparatus, large buildings, etc., will ultimately give way to small fast units, just as this has occurred in other industries over the past 50 years.

At the moment there is no evidence that ball and liner wear is prohibitively high. In fact, at the time Fahrenwald was demonstrating his high-speed horizontal machine at the meeting of the American Mining Congress, several years ago, he assured this writer that the balls retained their shape much longer than they do in conventional tumbling mills. Rods and balls that slide (as some operators in uranium plants are experiencing) get flat. Apparently the balls have a rolling action.

Mr. Hukki's references to the processing capacity of the Tennessee Copper Co. mills is adequate. Those studying this subject will be greatly interested in the paper presented by Richard Smith of the Cleveland-Cliffs Iron Co. at the annual meeting of the Canadian Institute of Mining and Metallurgy in Vancouver April 24, 1958. This paper will be published during the latter part of 1958 in the *Canadian Institute of Mining and Metallurgy Bulletin.*

Hukki's pioneering spirit is to be commended.

R. T. Hukki *(author's reply)*—It has been heartening to read the objective discussion by J. F. Myers. The sincerity of his opinions is further strengthened by the fact that the article he has discussed contradicts in a major way the parallel achievements of his life work.

Myers is right in his opinion that in general it takes a long time before new ideas are accepted by the industry. On the other hand, revolutions usually take place at supercritical speeds. There are many indications at present that both the unit operation of grinding and the related subject of size control are now just about ripe for a revolution. In grinding, brute force must ultimately give way to science. Rapid progress can be anticipated in the following fields:

1) Autogenous fine grinding at supercritical speeds will be the first advance and the one that will gain recognition most easily on industrial scale. At this moment, little Finland appears to be leading the world. Crocker recently made a statement that in nine cases out of ten, your own ore can be used as grinding medium more effectively and far more economically than steel balls. This is true. The present author would like to introduce a supplementary idea: In eight cases out of the nine cited above, it can be done at the highest overall efficiency in the supercritical speed range. Fine grinding must be based on attrition, not impact. The path of attrition may be vertical, horizontal, even inclined.

2) In coarse grinding, the conventional use of rods is sound practice. However, even the rods can be replaced by autogenous chunks large enough to offer the same impact momentum as the rods. To obtain the momentum, the chunks must be provided with a free fall through a sufficient height in horizontal mills operated at supercritical speeds. Coarse grinding must be based on impact. Detailed analysis of the subject may be found in a paper entitled "All-autogenous Grinding at Supercritical Speeds" in *Mine and Quarry Engineering*, July 1958.

3) All conventional methods of classification, including wet and dry cyclones, are inefficient in sharpness of separation. Continuous return of huge tonnages of finished material to the grinding unit with the circulating load is senseless practice. In the near future the present methods will be either replaced or supplemented by precision sizing.

These three fields are also the ones to which J. F. Myers has so admirably contributed in the past.

Correction

Fine Grinding at Supercritical Speeds. By R. T. Hukki (MINING ENGINEERING, May 1958). Eq. 9, page 588, should be as follows:

$$T = c_1 (\delta - \delta') n^{1.4} D^{2.7} L \text{ tph}$$

On page 584 of the article the captions for Figs. 4 and 5 have been placed under the wrong illustrations and should be interchanged.

REGISTRATION FORMS—Mid-America Minerals Conference

October 23, 24, 25 | St. Louis | Chase, Park-Plaza Hotels

Please fill out cards below and return with check to:

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REGISTRATION

Mid-America Minerals Conference, St. Louis,
October 23 to 25, 1958

Please fill out and mail all cards to:

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____ Advance Member Registrations @ $ 5.00 $____
____ Advance Nonmember Registrations @ $10.00 $____
____ Advance AIME Student Member Registrations, free
____ Advance Nonmember Student Registrations @ $ 1.00 $____

HOTEL RESERVATIONS

All hotel reservations should be made directly with hotels:

Chase Hotel
212 N. Kingshighway Blvd., St. Louis 8, Mo.
Telephone: FOrest 1-2500 Teletype SL 409

Park Plaza Hotel
220 N. Kingshighway Blvd., St. Louis 8, Mo.
Telephone: FOrest 7-3300 Teletype: SL 409

Name_____ Company_____

Address_____

SOCIAL PROGRAM

Thursday, October 23

____ Welcoming Luncheon, 12 noon @ $4.25 $____
____ Cocktail Party, 6:00 to 7:30 pm, free with registration

Friday, October 24

____ Dinner-Dance, 7:00 pm @ $9.00 $____

Name_____ Company_____

Address_____

FIELD TRIP RESERVATION

Thursday, October 23

____ Coal Trip, 8:00 am @ $2.00 $____
Peabody Coal Co., Freeburg, Ill., mine and barge loading facilities

OR

Friday, October 24

____ All-Day Mining and Milling Trip, 7 am to 5 pm @ $5.00 $____
Indian Creek Mine and Mill of St. Joseph Lead Co. near Potosi, Mo.; Pea Ridge deep iron shaft site.

OR

____ Granite City, 8 am to 12 noon @ $1.50 $____
Trip limited to 75; Granite City Steel Mill, Granite City, Ill.

OR

____ Dow Chemical, 8 am to 12 noon @ $1.50 $____
Trip limited to 200; Dow Chemical Co. magnesium extrusion and rolling plant

OR

____ Cement Trip, 8 am to 12 noon @ $1.50 $____
Trip limited to 100; Missouri Portland Cement Co.

Name_____ Address_____

_____

LADIES' PROGRAM

____ Registrations @ $1.00 $____

Thursday, October 23

____ Coffee Hour, 9:30 am to 11:30 am, free with registration

Friday, October 24

____ Luncheon, Fashion Show, 12:30 pm @ $5.50 $____

Saturday, October 25

____ Bus Tour of St. Louis, 9:30 am @ $2.25 $____

Tickets to events for which you have registered will be held in your name at the meeting registration desk.

Mid-America Minerals Conference

Thursday, October 23, AM

Minerals Beneficiation

R. H. Lowe, *Chairman*, and D. C. Spees, *Co-Chairman*

9:00—Recent Advances in Milling Practice: *H. A. Hoffman*, St. Joseph Lead Co.

9:30—Leaching Copper from Zinc Concentrates: *Norman Hedley* and *Howard Tabachnick*, American Cyanamid Co.

10:00—Application of Ore Dressing Microscopy: *C. G. Amstutz*, Missouri School of Mines.

10:30—Two-Stage Cyclones at White Pine: *Virgil Lessels*, White Pine Copper Co.

11:00—Bulk Solids Flow: *Andrew Jenicke*, University of Utah.

Geology and Geophysics

LeRoy Scharon, *Chairman*

9:00—Iron in Missouri, *John S. Brown*, St. Joseph Lead Co.

9:30—Kentucky Fluorspar District—Its Geology and Exploration: *John S. Tibbs*, Calvert City Chemical Co.

10:00—Geophysical Exploration Techniques: *Willard E. Davis*, U. S. Geological Survey.

10:30—Application of Geology to the Discovery of Zinc-Lead Ore in the Wisconsin-Illinois-Iowa District: *J. C. Bradbury*, Illinois Geological Survey.

11:00—Sedimentation Breccias in Southeastern Missouri Lead Mines: *Frank Snyder*, St. Joseph Lead Co.

Thursday, October 23, PM

Mining

Fred D. Wright, *Chairman*

1:30—Some Performance Parameters of Ammonium Nitrate-Fuel Oil Explosives: *George B. Clark*, Missouri School of Mines.

2:00—New Developments and Use of Ammonium Nitrate Explosives: *Dort F. Tikker*, Monsanto Chemical Co.

2:30—A Case History in Pillar Recovery: *John Reed*, St. Joseph Lead Co.

3:00—The Piokee Project—An Experiment in Mining Efficiency: *Joseph S. Elizondo*, The Eagle-Picher Co.

3:30—Blast-Hole Mining at Geco: *G. M. T. Marshall*, Geco Mines Ltd.

Coal

Jack A. Simon, *Chairman*, and Gene H. Utterbach, *Co-Chairman*

Coal Operations

1:30—Shaft Sinking and Lining in the Southern Illinois Coal Field: *J. W. MacDonald*, Old Ben Coal Corp.

2:00—Preparation of Fine Coal: *Emery Milligan*, Freeman Coal Corp.

2:30—Ventilating Problems in Continuous Mining Operations: *D. S. Kingery*, U. S. Bureau of Mines.

Coal Economics

3:00—Fuels Used in Manufacturing: *W. H. Voskuil*, Illinois State Geological Survey

3:30—Inventories—Aid and Deterrent to Coal Industry Stability: *H. E. Risser*, Illinois Geological Survey.

Friday, October 24, PM

Extractive Metallurgy

H. R. Bianco, *Chairman*

1:30—Developments in Cooperative Zinc Research: *D. W. Pettigrew*, American Zinc Inst.

2:00—Nickel and Cobalt Extraction at Fredericktown, Missouri: *R. M. McCormick*, National Lead Co.

2:30—Mechanical Charging of Horizontal Zinc Retorts: *B. F. Buff*, National Zinc Co.

3:00—Continuous Strip Galvanizing at Granite City: *Eloy M. Cueto*, Granite City Steel Co.

3:30—Continuous Casting of Magnesium: *John L. Scherer*, Dow Chemical Co.

Industrial Minerals

Thomas R. Beveridge, *Chairman*, and William Hayes, *Co-Chairman*

1:30—Fluorine Reserves and Potential Recovery from Domestic Phosphate Rock: *E. F. Dressner* and *G. F. Palm*, International Minerals and Chemical Corp.

2:00—Barite in Washington County, Missouri—History and Development: *E. L. H. Sackett*, National Lead Co.

2:30—Undeveloped Industrial Rocks and Minerals of Missouri: *T. R. Beveridge*, Missouri Geological Survey.

3:00—Utilization of Red Mud from Alumina Refining Plants: *N. L. Shepherd*, Aluminum Co. of America.

3:30—Shale Testing in Illinois for Lightweight Aggregates: *Arthur White*, Illinois Geological Survey.

4:00—A Study of Missouri Bloating Clays and a Suggestive Mechanism for the Bloating Process: *T. J. Plantje*, Missouri School of Mines.

Saturday, October 25, AM

Iron Symposium

Robert Geehan, *Chairman*

9:00—**Supply**
Trends Related to Sources of Iron Ore: *H. T. Reno*, Bureau of Mines.

9:30—**Geology and Prospecting**
Iron Ores of Missouri, with Special Reference to Recent Exploration: *William C. Hayes*, Missouri State Geologist.

10:00—**Drilling**
Drilling and Sampling Methods in East Texas: *A. B. Drescher*, Lone Star Steel Co.

10:30—**Mining**
Underground Mining of Iron Ore at the Ozark Ore Co. at Iron Mountain, Mo.: *R. P. Matson*, Ozark Ore Co.

11:00—**Milling**
Experiments in the Concentration of Iron Ore from the Pea Ridge Deposit, East Central Missouri: *M. M. Fine*, U. S. Bureau of Mines.

11:30—**Utilization**
Paper to be announced later.

Field Trips

Thursday, October 23, AM

Coal

Peabody Coal Co., Freeburg, Ill., mine and barge loading facilities; trip to start at 8 am.

or

Friday, October 24

All-Day Trip

7 am to 5 pm

Mining and Milling
Indian Creek Mine and Mill of St. Joseph Lead Co. near Potosi, Mo.; Pea Ridge deep iron shaft site.

or

Morning Trips

8 am to 12 noon

Extractive Metallurgy: Granite City Steel Mill, Granite City, Ill.

or

Dow Chemical Co., magnesium extrusion and rolling plant, Madison, Ill.

or

Cement: Missouri Portland Cement Co., mining and processing plant.

General Social Events

Thursday, October 23

Welcoming Luncheon

12:00 noon

Speaker: *Felix Wormser*, vice president, St. Joseph Lead Co.
Subject: *Economic Conditions in the Metal Industry*

Cocktail Party

6:00 to 7:30 pm

Sponsored by companies within the AIME St. Louis Section area.

Friday, October 24

Dinner-Dance

7:00 pm

Khorassan Room Chase Hotel
Speaker: *Augustus B. Kinzel*, AIME President, Union Carbide Corp.
Subject: *Metals, Missiles, and Men*

Ladies Program

Thursday, October 23

Coffee Hour

9:30 to 11:30 am

Friday, October 24

Luncheon and Fashion Show

12:30 pm

Tiara Room Park-Plaza Hotel
Fashion Show by Montalbo's.

Saturday, October 25

Bus Tour

9:30 am

Bus tour of city of St. Louis

SME BULLETIN BOARD

Reports of Your Technical Society

Forthcoming Meetings

Rocky Mountain Minerals Conference Program, page 895

AIME-ASME Joint Solid Fuels Conference, page 897

AIME 1959 Annual Meeting in San Francisco, page 898

Note, on page 904, biographies and pictures of Sherwin F. Kelly and Ewald Kipp. Their names were announced in last month's issue as M&E's nominations for SME Directors in 1959, but the names were received too late for inclusion of the full data.

Page 897

For information on non-AIME meetings to be held this fall and which will interest SME members, see items on pages 905 and 908.

Membership groups will again sponsor Local Section Guest Night in October—page 898.

Newsletters . . .

Coal

page 899

Rock in the Box

page 991

Cuba
909

Central Appalachian Local Section and Coal Division Spring Meeting report begins on pages 899, 902.

Report of recent actions by AIME Board of Directors is given on page 905, and includes a proposal for Bylaw change.

Proposals for Membership;
Change of Address/Personals Data Boxes

These forms appear on page 918 for your convenience

Typical of 71-B applications is this job in a western copper mine. Machine is loading out overburden. Note widespread crawlers which keep the big 71-B steady and stable throughout dig-and-swing cycle.

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Rocky Mountain Plans Include Field Trips, Papers, Social Events

The Fifth Annual Rocky Mountain Minerals Conference will take place in Salt Lake City, September 17 to 19, with outstanding technical sessions, special sessions on current engineering problems, and a symposium on modern management.

Field trips and tours will demonstrate the themes of the sessions, and a program for the ladies will top the list of social events.

The general chairman, A. J. Thuli, has arranged a variety of topics, complete with pre-session movies on *The Copper Network* and *Columbia-Geneva Coal Preparation Plant*. There will be discussion of education in mineral engineering and the place of automation in the mineral industry, combined with a thorough program of mineral studies, including *Atomic Fuel Costs vs. Fossil Fuel Costs For Power Production; Progress in Oil Shale; Innovations in Processing Nickel and Cobalt Ores;* and many other specific subjects.

The symposium on *Modern Management Techniques* will present a panel of specialists in the various phases of management who will give a comprehensive picture of new methods and practices. F. C. Green and L. F. Black will be co-moderators.

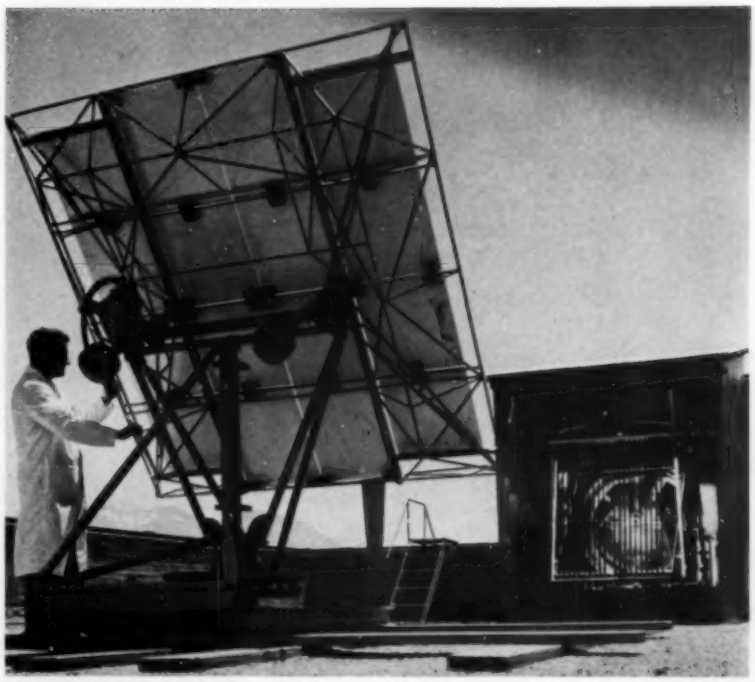
Field trips offer inspection of the Kennecott Research Laboratory, one of the most modern installations of its kind, complete with pilot plant for translating theoretical laboratory findings into operational procedures. The solar furnace will be the major highlight of this tour. Other stops will include the Bureau of Mines and the new atomic reactor at the University of Utah.

Another tour will take delegates to the Eimco Corp. where the famous Eimco loader is manufactured. Also on the trip will be the Western Phosphates Inc., where chemical fertilizer is made.

In addition, a scenic tour is planned for September 19 to view one of the most colorful canyons in "America's Switzerland," Big Cottonwood Canyon, and the village where a chair lift swings you up Mt. Millicent to survey the vast panorama.

Special speakers for the conference will highlight the luncheons, with a welcoming address the opening day by the Honorable George D. Clyde, Governor of Utah. At the minerals luncheon on Thursday the guest speaker will be Howard C. Pyle, President-Elect of AIME.

Social activities will spotlight the program with opportunities for informal get-togethers and special features for attending wives. The coffee party for the ladies on the opening day has been favorably welcomed at past conferences, giving the ladies a chance to get acquainted informally.



The solar furnace at the Research Center of Kennecott Copper Corp. will be demonstrated during the field trip to the University of Utah Campus in Salt Lake City, at the Rocky Mountain Minerals Conference, September 17 to 19, at the Newhouse Hotel.

That evening the mining companies and suppliers in the area will sponsor a cocktail party for more relaxation with newly formed friends. On Thursday the ladies will be treated to a smart fashion show of fall and winter styles at the Salt Lake Country Club, with a pleasant luncheon as the setting, and a tour through the beautiful residential sections of the city.

The final day will begin with a miner's breakfast open to all, and will end with cocktails and a dinner-dance at the Newhouse Hotel, headquarters for the entire conference.

Host for the conference is the Utah Section, R. C. Cole, chairman; and the Woman's Auxiliary, with Mrs. Ralph Tuck as chairman, prepared the ladies events.

Program

Technical Sessions

Wednesday, September 17, am

Pre-Session Movie: The Copper Network

Innovations in Processing Nickel and Cobalt Ores: *J. B. Clemmer*, U. S. Bureau of Mines.

Characteristics of the Oil Fields in Southeastern Paradox Basin: *W. Don Quigley*, consulting geologist.

Trends in Mineral Engineering Education: *John W. Vanderwilt*, president, Colorado School of Mines.

Use of Yieldable Steel Supports in Caved and Heavy Ground: *James Quigley*, vice president, Centennial Development Co.

Wednesday, September 17, pm

Effect and Control of Impurities in Electro-winning of Zinc: *Guy T. Wever*, The Anaconda Co.

The Place of Automation in the Minerals Industry: *J. E. Lawver*, International Minerals & Chemical Corp.

Tectonic History of the Basin and Range Province, Utah and Nevada: *John C. Osmond*, Gulf Oil Corp.

Thursday, September 18, am

Pre-Session Movie: Columbia-Geneva Coal Preparation Plant

The Developments in Core Drilling Techniques for Deep Mineral Exploration: *J. K. Hayes and Vernon Read*, Columbia Iron Mining Co.

Calculation and Recording of Ore Reserves at Butte, Montana: *C. C. Goddard*, The Anaconda Co.

Clays of the Intermountain Area: Uses, Markets and Future: *C. A. Freeman*, Freeman Fire Brick Co.

Recent Developments in Pebble Milling: *B. S. Crocker*, Kilborn Engineering Ltd.

Thursday, September 18, pm

Progress in Commercial Atomic Power: *W. L. Budge*, Westinghouse Atomic Power Dept.

Coal and Utah: *James L. Spindler*, University of Utah, Prize Winning Student Paper.

Progress in Oil Shale: *Fred L. Hartley*, Union Oil Co.

Mining Practice at Ambrosia Lake, New Mexico: *Donald T. Delicate*, Homestake-Sapin Partners.

(Continued on page 898)

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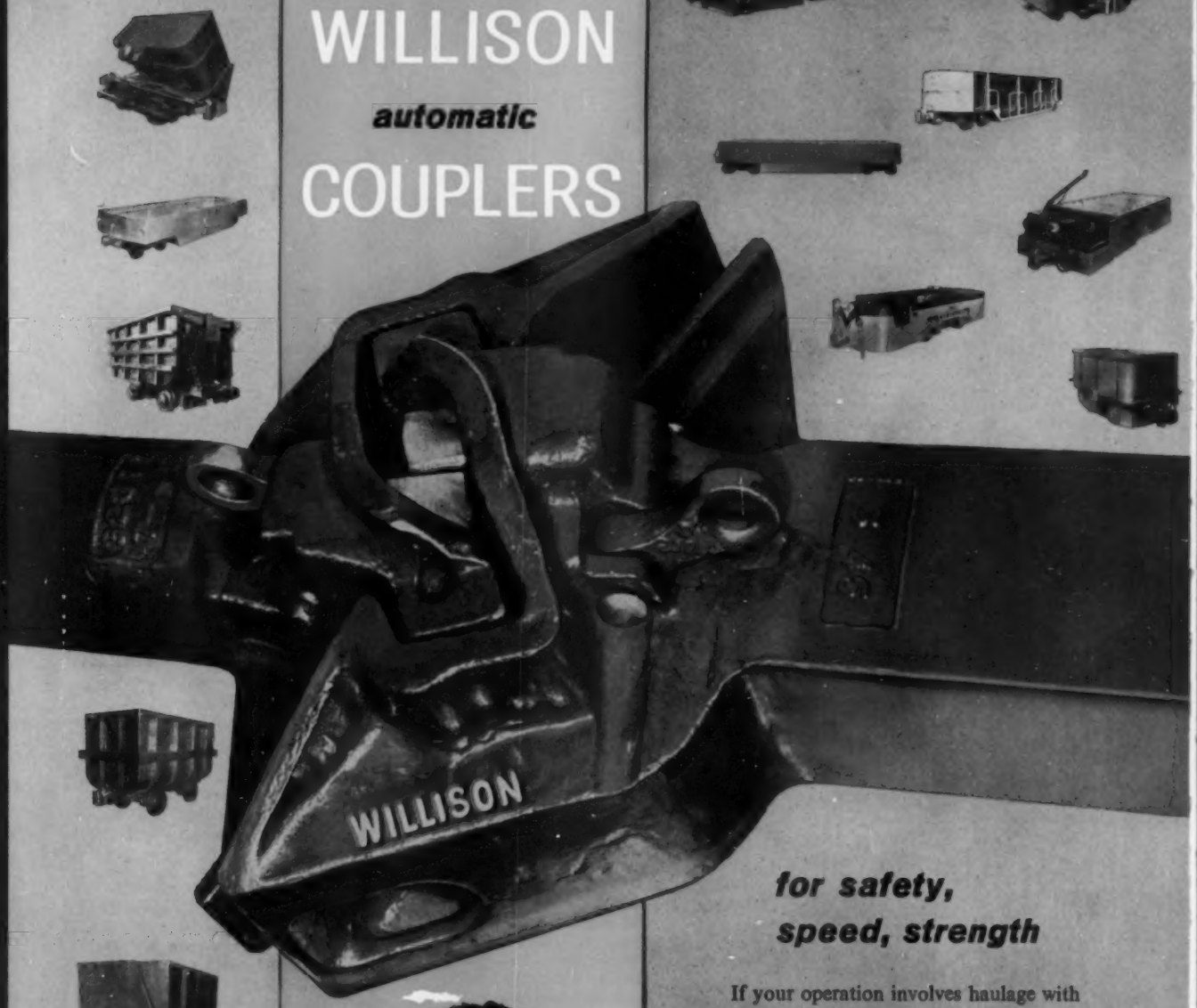

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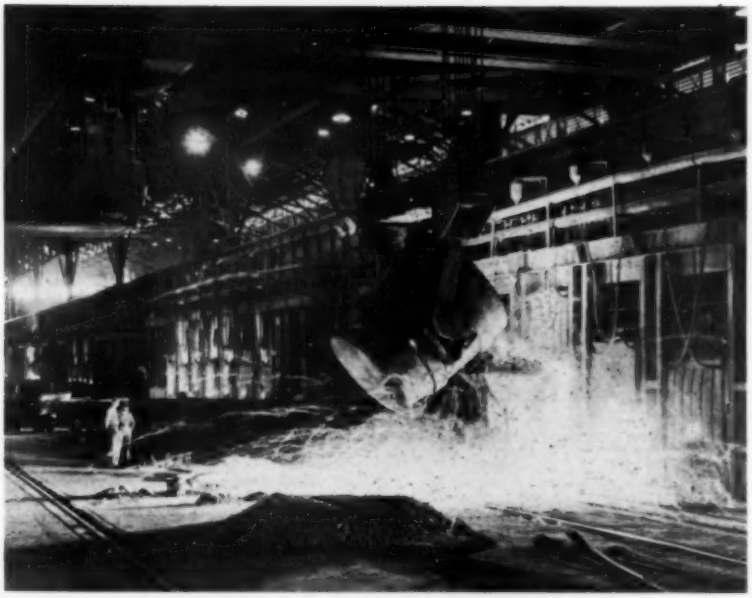

Comparison of the figures on the left and ladle gives some idea of the proportions of the Granite City mill to be visited by registrants at the Mid-America Minerals Conference in October. An adventure in modern steelmaking awaits engineers at Granite.

Mid-America Minerals Conference To Feature Comprehensive Program

Extensive preparations for the Mid-America Minerals Conference promise a comprehensive program of technical sessions, field trips, and social events, with a special program for the ladies. St. Louis is the convention city for this October 23 to 25 gathering, and reservations can be secured promptly by using the forms on p. 892A. G. Donald Emigh is directing the planning and programming and is responsible for the wide choice of sessions that have been scheduled.

The minerals beneficiation division co-chairmen, R. H. Lowe and D. C. Spees, have lined up the interesting topics of recent advances in milling practices and two-stage cyclones at White Pine Copper Co. Leaching copper, application of ore dressing, and bulk solids flow will also be discussed.

Geophysical exploration techniques will be one of the featured discussions on the geology and geophysics session. Leroy Scharon is the chairman responsible for the subjects to be presented, including talks on iron, fluorspar, and the discovery of Pb-Zn ore.

The mining session will present new developments in ammonium nitrate explosives and some studies of specific projects. Fred D. Wright will chair this session on Thursday morning, October 23.

Thomas R. Beveridge will be the chairman of the industrial minerals session and will introduce a paper himself on undeveloped rocks and minerals of Missouri. Shale testing, fluorine reserves, barite, red mud, and bloating clays will also be covered by the lectures.

The coal technical session is divided into operations and economics, featuring ventilation problems, preparation of fine coal, and fuels used in manufacturing. Jack A. Simon and Gene H. Utterbach will be the co-chairmen.

H. R. Bianco will lead the extractive metallurgy session covering developments in cooperative zinc research, continuous strip galvanizing, and nickel and cobalt extraction.

The final session will be an iron symposium covering the general subjects of supply, geology and prospecting, drilling, mining, milling, and utilization. Robert Geehan is the session chairman.

Technical sessions are not the only educational part of the program, for several field trips have been planned. LeRon Scharon and Fred Meek are responsible for this part of the conference and they have arranged three morning trips and one all-day excursion. A mining and milling trip will be conducted to the Indian Creek mine and mill of St. Joseph Lead Co. from 7 am to 5 pm on Friday. Half-day trips will take those interested in extractive metallurgy to the Granite City Steel Co. mill and Dow Chemical Co. Coal and cement will be observed at the Peabody Coal Co. and the Missouri Portland Cement Co.

The general social program will include a welcoming luncheon with Felix Wormser, vice president of St. Joseph Lead Co., as guest speaker. That evening the companies within the St. Louis Section area will sponsor a cocktail party.

On Friday the conference will be highlighted by a dinner dance, with special speaker Augustus B. Kinzel, President of AIME, who will talk on *Metals, Missiles, and Men*. In addition to the planned social program there will be many entertaining opportunities in St. Louis and in the hotels themselves, where top stars spotlight the nightclubs and theaters.

The ladies program welcomes attending wives to the luncheon and cocktail party and dinner dance, held in the lovely Khorassan Room in the Chase Hotel, and features a special luncheon and fashion show on Friday in the Tiara Room at the Park Plaza. On Saturday the ladies may tour the city by special bus arranged for the conference.

The seven technical sessions cover a wide range of interests for mining and metallurgical engineers and the field trips present a choice for everyone. The conference has been planned to attract all members of AIME from far and wide.

Mining and Mechanical Men Will Convene At Solid Fuels Conference

The mining and mechanical engineers will gather together this fall for the AIME-ASME Joint Solid Fuels Conference in Virginia. The site they have chosen is Old Point Comfort at Fort Monroe, Va., where they plan to stay at the luxurious oceanside Hotel Chamberlin—October 9 and 10 are the dates.

The papers to be presented cover three general areas: fundamental theoretical knowledge, bulk coal and ash handling, and operation and performance. The three sessions will take place Thursday morning, Friday morning, and Friday afternoon, with a field trip arranged for Thursday afternoon.

Co-chairmen of the opening session are H. V. Mansfield and T. S. Spicer, of ASME and AIME, respectively. They will lead discussion on such interesting topics as design considerations for pneumatic coal handling and dock handling of ores.

At the luncheon between the morning session and the field trip, S. Pemberton Hutchinson will speak on *The Export Coal Market*.

The following morning the technical session will be opened by co-chairmen Carl S. Dennis and H. B. Lammers who will introduce the lecturers and such topics as coal drying, and equipment and procedure for carload sampling.

The final session Friday afternoon will include papers on the first cyclone furnace fired boiler in the southeast and low coke button bituminous anthracite equipment. Frank Feeley, Jr., and C. F. Hardy will be the session chairmen.

Make October Guest Month

Invite an associate to attend the October meeting of your Local Section.

Show him AIME in action.

Tell him of other AIME meetings he would be interested in attending. (Refer to page 829 for Coming Events.)

Ask him to fill in an application blank.

Every mining man should be a member of SME of AIME.

Rocky Mt. Program

(Continued from page 895)

Friday, September 19, am

Symposium—Modern Management Techniques: *F. C. Green and L. F. Black,* co-moderators.

Social Activities

Wednesday, September 17

Welcoming Luncheon
12:30 to 2:00 pm Newhouse Hotel
Speaker: *The Honorable George D. Clyde,* Governor of Utah

Mining Companies and Suppliers Cocktail Party
6:30 to 9:00 pm Newhouse Hotel

Thursday, September 18

Minerals Luncheon
12:30 to 2:00 pm Newhouse Hotel
Speaker: *Howard C. Pyle,* AIME President-Elect

Friday, September 19

Miner's Breakfast
7:30 to 9:00 am Newhouse Hotel

Field Trips
To take place in the afternoon.
1) Kennecott Research Center, Bureau of Mines, University of Utah Reactor Installation
2) Eimco Corp. and Western Phosphates Inc.
3) Scenic Tour Up Big Cottonwood Canyon to Brighton

Cocktails and Dinner Dance
7:00 pm Newhouse Hotel

Ladies' Program

Wednesday, September 17

Ladies' Coffee Party
9:00 to 11:00 am Newhouse Hotel

Thursday, September 18

Ladies' Luncheon and Fashion Show
12:30 to 2:00 pm
Salt Lake Country Club

Rock in the Box

(Continued from page 901)

will clear up an omission on who should nominate the Directors to represent M&E.

Underground Mining Unit

R. J. Lacy, M&E Program Chairman, has announced that S. K. Droubay will handle programming for the underground Mining Unit. His address: S. K. Droubay, The Anaconda Co., Kearns Bldg., Salt Lake City, Utah.

SME and Divisions Cite Rapid Strides in Plans And Program for Annual February AIME Meeting

The AIME Annual Meeting will be held in San Francisco Feb. 15 to 19, 1959. The hotels already chosen for headquarters are the Sheraton-Plaza for SME, the Sir Francis Drake for SPE and the St. Francis for The Metallurgical Society.

A general mailing piece on the 1959 Annual Meeting will be sent out by the Institute in late fall 1958. Included will be a hotel reservation form to be sent to the San Francisco housing bureau, the clearing house for all reservations. The committee for the meeting has advised that members wait for the form they will receive in due course, rather than trying to make reservations directly with the hotels, since such reservations will not be accepted.

Preparations for technical sessions are being made and authors are urged to keep in mind the dates and requirements for papers to be submitted. A three-phase preparation has been suggested, starting with a 250-word abstract, then condensing the manuscript to a 20-min. presentation, including illustration display time, and finally submitting the paper for preprinting by SME and possible publication in AIME Transactions. The program chairmen must submit the abstracts by October 1, so all authors should present their papers to the chairmen not later than September 25.

The SME Divisions have set up tentative plans for technical sessions and are hard at work making definite arrangements. The Coal Division will have three sessions, with three or four papers per session and preplanned discussion from the floor. Consideration of papers from the western states will be given with respect to the large representation expected. The committees planning the program are the Systems of Mining Committee, Jesse F. Core, chairman; Safety Committee, Carl A. Peterson, chairman; and Maintenance of Equipment Committee, C. L. Sarff, chairman.

The Industrial Minerals program will include seven sessions with four or five papers each. Special problems and their solutions will be highlighted, with an emphasis on new developments and thinking in the field. Some of the subjects to be covered are: rare and radioactive minerals, industrial waters, chemical raw materials, ceramic raw materials, and industrial minerals economics. Joint sessions with SEG will include fillers, fibers, and pigments with special sands and abrasives; cement, lime, gypsum; mineral aggregates; and dimensional stone.

(Continued on page 908)

Lexington Meeting

One of the ways in which engineers benefit from their membership in a professional society is through the opportunities offered by meetings—local, regional, and national. At such meetings, members have a chance to meet with others in their special fields of interest, to exchange notes on problems and technical developments.

Such opportunities were available at the Central Appalachian Local Section and Coal Division meeting in Lexington, Ky., June 13 and 14.

Division Chairman J. W. Woomer, who presided at the Friday luncheon, pursued the membership theme when he presented membership statistics for the edification of his audience. He urged each member to actively encourage others to join, in order that the Division continue its steady growth. Only through growth and active interest can the Division continue to be a vital and strengthening asset to the profession it serves.

Mr. Woomer also reported to those present the progress of the various fund campaigns for the new United Engineering Center in New York. Of the $5 million to be raised, $3 million had been pledged by June.

The Friday morning session was for all attending the meeting and W. J. Skewes and V. C. Smith presided. Greetings to the registrants were conveyed from the Hon. Shelby C. Kinkead, mayor of Lexington. W. F. Diamond discussed *Shafts vs. Slopes for Deep Mines* and Robert A. Laurence of the USGS surveyed *The Defense Minerals Exploration Program in the Eastern States.*

Of the four technical sessions at the meeting, two were devoted exclusively to coal. In addition to the speakers shown below, Gregory Krebs presented a paper at the Friday session on plugging or sealing oil and gas wells in coal fields. The Saturday speakers and their subjects are given below.

At the Friday luncheon at which Mr. Woomer presided, Frank G. Dickey, president of the University of Kentucky, was the guest speaker. His topic—*How the University of Kentucky is Meeting the Challenge of Kentucky's Expanding Industry*—emphasized the relationship of higher education to industrial expansion, a problem the Coal Division education groups are also challenging on a professional scale. Human resources, Dr. Dickey maintained, demand better development in the future. Industrial progress will require bold planning, clear vision, and above all, prompt action, with cooperation from industry, government, and education, he declared.

At this luncheon, Mr. Woomer conveyed greetings from Augustus B. Kinzel, and S. D. Michaelson, AIME and SME Presidents.

For further news of the meeting—other sessions, speakers, social events, and ladies' program—see pp. 902 and 903.

San Francisco Program

The Division has participated in local and regional meetings this year (AIME-ASME Joint Solid Fuels Conference, p. 897; Mid-America, p. 892B; and the Central Appalachian meeting discussed here). Now the Program Committee's attention is concentrated upon plans for a national meeting—AIME Annual Meeting in San Francisco in February 1959.

The chairman of the Program Committee met early this year with the General Chairman of the Preparation Committee and the three chairmen of the Preparation Subcommittees. The men report that they are planning three papers per session with ample allowance for discussion from the floor.

In the total of seven sessions to be scheduled by the Coal Division in San Francisco, the Preparation Committee is preparing two; and there will be one each for Safety, Systems of Mining, Maintenance of Equipment, Carbonization and Gasification, and Combustion Committees.

Coal's Program Committee hopes to limit all sessions to a maximum of four papers to insure ample discussion time. This is being done by the Preparation Committee.

In recognition of the locale of the meeting, the committee has kept in mind the probable large representation from the western states and hopes to make the program particularly interesting for this group.

Some of the authors and chairmen at the fuels sessions in Lexington paused long enough to have their photographs taken. The Friday afternoon session was devoted to operational problems. In the group at left, Henry Hebley and John D. Kalasky presented papers on, respectively, coal washing plants and ventilation for continuous miners. Byron M. Finch, center, was one of the interested audience. C. W. Connor, Jr., and C. S. Crouse were chairmen for the session. On the right, William E. Foreman, E. H. Roberts, David Springston, and M. D. Cooper discuss transportation problems at the Saturday session. Messrs. Foreman and Springston presented papers on the cost of coal delivered to power plants and hydraulic transportation of solids. Session chairman was E. H. Roberts.

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ROCK IN THE BOX

Mining & Exploration Division

Some of the Units of M&E are making rapid strides in plans for the 1959 AIME Annual Meeting in San Francisco. Reporting details (summarized here) are the Geology, Geochemistry and Geophysics Units. Reports from Underground and Open Pit will be announced in *Rock in the Box* as they are received.

The Division has been striving for several years both to reduce program session conflicts at Annual Meetings and to promote the presentation of a wider range of topics so that miners, geologists, and geophysicists may attend each other's sessions on the grounds of common interest. This year joint sessions will be emphasized in the hope of providing a program irresistible to broad membership of the Division.

Geology Unit

The program chairman for the Geology Unit is S. E. Jerome, district geologist, Coordinating Unit, Bear Creek Mining Co. Mr. Jerome received his B.Sc. in economic geology from the University of Michigan in 1937 and worked as a mining and exploration geologist in Colorado, New Mexico, and Arizona for The New Jersey Zinc Co. He has been a lecturer at the University of Utah, where in 1956 he received his doctorate in geology. Earlier he had been chief geologist for Gulf Minerals Co. and since 1956 he has held his present job with Bear Creek.

According to his report, the program committee is planning an exploration symposium involving the geology, geophysics, and geochemistry groups. A panel of ten experts from these fields will discuss questions of particular interest to those engaged in mining exploration. H. E. McKinstry will be the symposium moderator and will lead discussion from the floor. Representatives from government and management will also present their views.

Second Joint Session

The report from the Geophysics and Geochemistry Units adds that a second session for the three exploration units will feature case history-type papers involving all three earth sciences. Already definite are papers on operations in Canada and Colorado.

There will be separate meetings, with papers on very specialized

S. E. JEROME

topics of interest to members of each unit.

Geophysics and Geochemistry

Since the work of the Geophysics and Geochemistry Units is being handled as a joint venture this year, the chairman of both units is Stanley H. Ward, consulting geophysicist from Toronto. Mr. Ward graduated with honors in engineering physics from the University of Toronto in 1949 and received an M.A. and Ph.D. there in geophysics. He has been chief geophysicist and managing director of McPhar Geophysics Ltd. and of Nucom Ltd., a subsidiary of the American Metal Co. Ltd. He has traveled for these companies in Canada, U. S., Cyprus, and Africa, gaining experience in mining exploration with methods such as airborne and ground electromagnetic and gravimetric techniques, resistivity, self-potential, and induced polarization. He has devoted considerable time to research on these methods and has written numerous papers, including one to be presented at the Annual Meeting.

In addition to the two joint sessions already mentioned, the Geophysics and Geochemistry Units will participate in a third one on specific geochemical and geophysical techniques and/or application of them (see the comment below by Bob Searls). Two papers already lined up for the session cover the variable frequency method of induced polarization and a new airborne and ground electrical prospecting technique. If enough interest in this session is shown and paper promises are made good, the session may be expanded into two.

Suggestions for the final preparation of the sessions would be greatly appreciated by both chairmen (*S. E. Jerome*, Bear Creek Mining Co., 2121 South State St., Salt Lake City 15, Utah, and *Stanley H. Ward*, Office No. 15, Office Mezzanine, 37 King St. East, Toronto, Ont., Canada.)

Exploration Techniques

Robert J. Searls, chairman of the Geophysics Unit, has said that he considers the proposed joint symposium on exploration techniques "the most promising event of the year." He adds that an increasing number of inquiries have been received concerning the application of seismic methods to mining exploration. If members would like to have *Mining Exploration with Seismic Methods* discussed at the meeting, they should contact Stanley Ward who will expand the topic if interest is widespread.

Deadlines

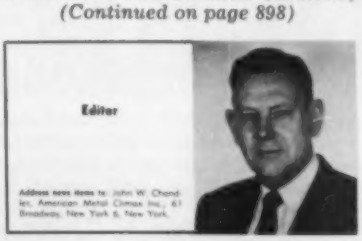
Deadlines are fast approaching for selection of papers for all the sessions. Abstracts must be sent to R. J. Lacy, M&E Vice Chairman for Programs, by September 24, so that manuscripts can be sent to Jack Fox at SME headquarters by October 15. For further information on paper preparation, for addresses of committee men, and for deadlines, see the July issue, page 805.

Change in Bylaws

Since the M&E Bylaws are new, errors or omissions were bound to appear. For matters of clarification, it is proposed that **Article III**, *Section 2*, be amended to read:

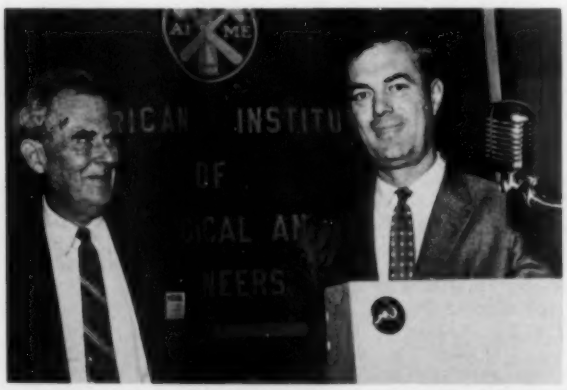
"Nomination and Election of Officers: The Nominating Committee shall report to the Chairman (of the Division) on or before May 15 the nominees for Chairman, and *two nominees each year for the post of Society of Mining Engineers' Director. These Directors should be chosen to provide adequate representation on the SME Board from each of the fields covered by the Division.* In turn, the Chairman shall arrange for the publication of names submitted" . . . This addition (in *italic*)

(Continued on page 898)



Central Appalachian Section and SME Coal Division Sponsor Joint

Program for the two-day meeting was filled with technical sessions and social events. Above: at the joint technical and opening session on Friday morning were W. J. Skewes, session chairman; H. O. Zimmerman, Section chairman who officially opened the Lexington conference; Robert A. Laurence, a speaker; and Velair C. Smith, session co-chairman. Top right are S. M. Cassidy, toastmaster for the Friday dinner who introduced George W. Hubley, Jr., seated. Mr. Hubley is commissioner of economic development in the State of Kentucky. He kindly substituted as speaker for Governor Happy Chandler who was unable to attend. State officials at the meeting were, right, James H. Phalan, chief of the Dept. of Mines and Minerals, and Paul P. Gannon, director, Div. of Strip Mining and Reclamation, Div. of Conservation, State of Kentucky.



At lunch on Friday, Frank G. Dickey, left, president of the University of Kentucky, was introduced by S. C. Crouse. Right: snapped at the Friday afternoon nonfuels session were, left to right, G. R. Spindler, session chairman, and two authors, Preston McGrain and W. T. Stuart. Messrs. McGrain and Stuart presented information on mine-water problems and Kentucky's clay and shale resources.

Section, Division, SME, state, and industry notables were seated at the head table for the dinner on Friday. Left to right are: Robert A. Laurence, meeting program committee; Edward G. Fox, Coal Executive Committee; George E. Keller, Coal Secretary-Treasurer; John C. Fox, SME Secretary; Charles T. Holland and G. R. Spindler; Coal Executive Committee; Samuel M. Cassidy, toastmaster; George W. Hubley, Jr., guest speaker; H. O. Zimmerman, Central Appalachian Section Chairman; J. W. Woomer, Coal Division Chairman; James M. Phalan and Paul P. Gannon, Dept. of Mines and Minerals and Div. of Conservation, Commonwealth of Kentucky; David A. Zeeger, W. J. Skewes, and Carel Robinson, Section Vice Chairmen; and V. W. Buys an industry representative.

June Meeting in Lexington, Ky.

The Central Appalachian Section and the SME Coal Division joined forces in Lexington, Ky., on June 13 and 14. Separate technical sessions, joint social events, and a ladies program combined to total a successful conference.

For news of the coal sessions and details of the Friday luncheon, turn to page 899 and the Coal Division *News*.

Nonfuels Technical Sessions

The nonfuels sessions of the meeting included eight papers on industrial minerals and related subjects. The Friday afternoon session was opened by G. Ralph Spindler and D. Keith Lupton, co-chairmen. Wilbur T. Stuart described the interpretation of typical mine water pumping measurements in terms of geologic controls. Robert L. Bates, geology professor at Ohio State University, then spoke on the difficulties in using the present classification of the nonfuel nonmetallics. The concluding talk of this session was by Preston McGrain, assistant state geologist of Kentucky. He discussed the distribution of the clay and shale resources of the state.

Robert A. Laurence presided at the Saturday morning session. Duncan J. McGregor, head of the Industrial Minerals Section of the Geological Survey of Indiana, described the research program on expandable shales in which his agency is vigorously engaged. John S. Tibbs spoke on *Modern Practices in the Production of Fluorspar in Kentucky*. The final papers were presented by Ned M. Smith and Charles W. Wilson on *Lithologic Guides for Exploration and Development of Salem Dimension Limestone Quarries in Indiana* and *The Geology of the Phosphate-bearing Bigby-Cannon Limestone of Middle Tennessee*.

Social Events and Speakers

In addition to the technical sessions there were luncheon and dinner speakers and various social events. The Friday luncheon included a talk by Frank G. Dickey, president of the University of Kentucky. H. O. Zimmerman, chairman of the Central Appalachian Section, presided at dinner on Friday and introduced S. M. Cassidy as toastmaster. He spoke on the problems Kentucky faced and the solutions proposed by the administration. The speaker, George W. Hubley, Jr., head of the Dept. of Economic Development of Kentucky, spoke on *Economy Now and Tomorrow*, stating that the recession could end if the gross national product were allowed to develop unhindered, aided by tax reforms. At the Saturday luncheon problems of attendance and future program preparation were discussed.

Ladies' Program

The social activities for the ladies featured lunch at the Colonial Inn and visits to Ashland to see the homes of Henry Clay and John Hunt Morgan. A social hour preceded the dinner, and visits to horse farms highlighted Saturday.

Committees for the meeting were comprised of Coal Division and Central Appalachian Section members. The program committee was headed by Carel Robinson, chairman, and his assistants: J. H. Mosgrove, C. H. Irwin, L. C. Gates, C. W. Connor, Jr., C. R. Nailer, D. Keith Lupton, John C. Ludlum, and R. A. Laurence. The latter three were responsible for planning the nonfuels sessions at the meeting.

Arrangements committee members were: E. M. Spokes, chairman; C. H. Hodgson; Joseph Malesky; W. H. Roll; and O. S. Batten.

The ladies' program was arranged by Mrs. E. M. Spokes, Mrs. W. H. Roll, Mrs. R. E. Swift, Mrs. C. H. Hodgson, Mrs. Carel Robinson, and Mrs. H. O. Zimmerman.

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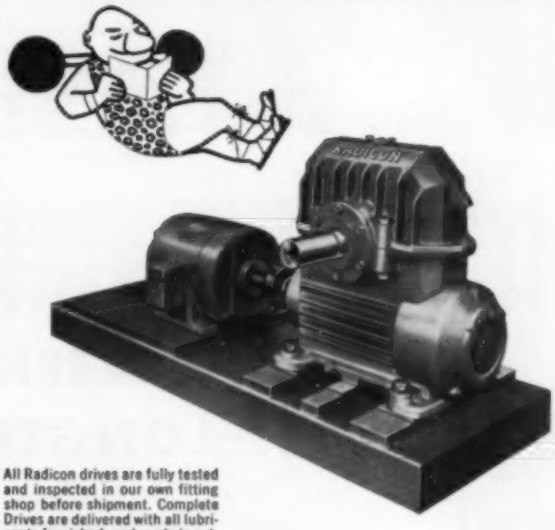

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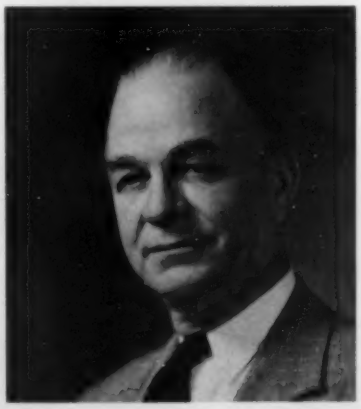
S. F. KELLY

Kelly, Kipp Nominated As M&E Representatives On SME Board in 1959

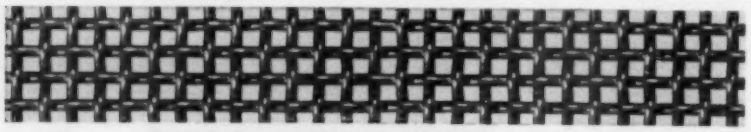
The Mining & Exploration Division has nominated Sherwin Kelly and Ewald Kipp to serve three-year terms on Society of Mining Engineers' Board of Directors, to take office in February 1959. Other SME nominations appeared in July MINING ENGINEERING; see p. 805 of that issue for Bylaw regulations pertaining to nominations.

Sherwin F. Kelly, presently serving as SME Director and head of the Society Advertising Committee, is an alumnus in mining engineering from the University of Kansas where he did graduate work after the war. He also studied geology and mineralogy at the University of Toronto, the Sorbonne, and Ecole des Mines in Paris. He was a pioneer in the introduction of geophysical techniques in the U. S. and Canada in 1921, in association with the Schlumberger firm of Paris, with which he was connected for several years. Mr. Kelly served as chairman of the AIME Geophysics Committee and of the Geophysics Education Committee, and later as chairman of the Geophysics Subdivision. He has served as chairman of several CIM committees and has been active in the affairs of UPADI (Pan-American Federation of Engineering Soc.) as an AIME representative on the Committee on International Relations of EJC. He is president of two geophysical exploration companies, Sherwin F. Kelly Geophysical Services Inc., Amawalk, N. Y., and Geophysical Explorations Ltd. of Toronto.

Ewald Kipp, Eimco Corp., Salt Lake City, has been nominated for Director of SME for a three-year term. Born in 1899, he graduated from the Texas College of Mines and Metallurgy (Texas Western) in 1922 and began work as a laborer, matte tapper, and slag skimmer for the El Paso Smelting Works, a subsidiary of American Smelting and Refining Co. He spent three years as shift boss in Mexico for the Cananea Consolidated Copper Co. before returning to Asarco as flotation operator and shift boss in the Pb-Zn mill in the Parral District, Santa Barbara, Mexico. He then rounded out his mining experience by working for the United Verde Copper Co. in Arizona. Like so many, Mr. Kipp lost his mining job in the Depression, but he shortly became special representative for Pan-American Airways, making use of his knowledge of Spanish. In 1936 he worked for the Sullivan Machinery Co. and after nine years he joined his present employer, the Eimco Corp. in Salt Lake City. As M&E men on the SME Board, Mr. Kipp will be especially representing the mining units and Mr. Kelly, the geophysics unit.



E. KIPP



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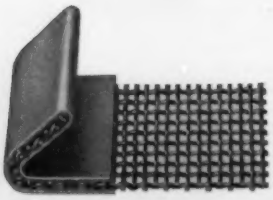

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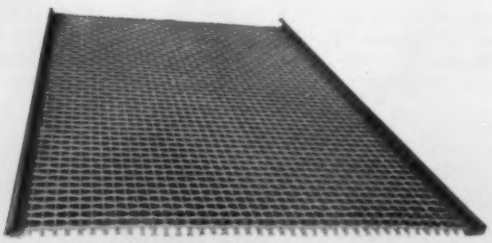

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Fifth UPADI Convention To Be Held in Montreal

The Fifth UPADI Convention will be held in Montreal September 2 to 6. The schedule begins with a business meeting Tuesday morning and committee meetings in the afternoon, including administration, public relations, budget, legislation, and technical matters. In the evening the convention will be officially opened with addresses by the president of the UPADI board of directors, the president of the Engineering Inst. of Canada, and various delegates. A reception, given by the Engineering Institute of Canada, will follow.

A highlight of the week's meetings will be a Conference on Engineering Education. There will be a grand banquet and ball on Friday evening. The closing sessions on Saturday will include voting on resolutions, elections, and a summary of the Conference.

AIME

BOARD OF DIRECTORS

Recent actions taken by the Institute Board of Directors.

► The following change in the AIME Bylaws has been proposed: **Article III**, *Section 1*—Change "Admissions Fees" to "Entrance Fees." Change to be made wherever applicable in Bylaws and Rules.

► Augustus B. Kinzel represented the AIME Board of Directors at the Golden Jubilee of AIChE during the week of June 22 to 27, 1958, and presented a Scroll of Greetings to the chemical engineering group from the Institute.

► Augustus B. Kinzel has been appointed as AIME representative to a four-year term on the John Fritz Medal Board of Award. F. B. Foley has been reappointed as alternate.

► The following personnel have been appointed for the Committee on Honorary Membership: H. DeWitt Smith, chairman; C. E. Reistle, Jr., 1959, Grover J. Holt, 1959, L. F. Reinartz, 1959, ex-officios as Past-Presidents of AIME; M. L. Haider, 1960, D. H. McLaughlin, 1961, John M. Lovejoy, 1962, and Augustus B. Kinzel, ex-officio as AIME President.

► H. N. Appleton and John F. Lynch have been appointed AIME representatives to the Engineering Societies Personnel Service.

► H. H. Chiswik was appointed AIME representative to the 1959 EJC Nuclear Congress and will serve on the Conference Committee.

► J. C. Fulton, Chairman of the ISD Publications Committee, has been appointed to the Rossiter W. Raymond Award Committee.

► The AIME Board of Directors will meet in Salt Lake City on Friday afternoon, Sept. 19, 1958, at 2 pm during the AIME Rocky Mountain Minerals Conference.

► J. C. Kinnear, Jr., was appointed Contact Director on the AIME Board at the Executive Committee Meeting of the Council of Education.

► In accordance with AIME Bylaws, *Article V*, **Section 4(a)**, President Augustus B. Kinzel has appointed J. S. Vanick as Contact Director to coordinate the rules of the three Society Admissions Committees.

► J. Roy Gordon, executive vice president of International Nickel Co. Inc., was appointed alternate to H. DeWitt Smith on the Hoover Medal Board of Award for a term to expire in 1960.

► John D. Sullivan has been nominated as AIME representative on the Advisory Board of the Office of Critical Tables of the Academy Research Council, National Academy of Sciences.

► Frank Sisco has been reappointed as AIME representative on the Engineering Societies Library Board for a four-year term.

► R. A. Beals has been appointed AIME representative to the American Standards Assn., Sectional Committee Y10, Letter Symbols.

► Thor Rhodin, chairman of the IMD Committee on Corrosion Resistant Metals, has been appointed AIME representative to the National Assn. of Corrosion Engineers, Inter Society Corrosion Committee.

► Frank Sisco has been appointed as AIME representative to a three-year term on the National Research Council.

► Andrew Fletcher and Frank Sisco will represent AIME on the Engineering Societies Library Study Committee.

► Revised Bylaws of the Florida Section have been approved.

► The AIME Research Committee has approved sponsorship by the Engineering Foundation of the following projects: project 32, *Alloys of Iron*, under Alloys of Iron Committee, Frank T. Sisco, director; project 80, *Heat Flow in Quenching*, under Victor Paschkis, Columbia University; project 97, *Diffusion in Steel*, under Morris Cohen, Massachusetts Institute of Technology; project 104, *Comminution*, under J. H. Brown, MIT; project 110, *Corrosion Research Council*, under the chairmanship of F. L. LaQue; project 112, *Flow of Bulk Solids*, under Andrew Jenike at Utah Engineering Experiment Station; project 123, *Thickening and Thickeners*, under A. M. Gaudin, MIT. The tentative project 135, *Documentation Research in Engineering*, by Center of Documentation and Communication Research, Western Reserve University, has been approved on the basis that the majority of members feel this is a worthwhile endeavor, although some members expressed doubts that this work is within the scope of interests of the Engineering Foundation.

► John M. Lovejoy and his two alternates, Michael Haider and Harold Decker, have been reappointed for six-year terms as AIME representative and alternates on the Hoover Medal Board of Award.

► Approval has been given for the Henry L. Doherty Memorial Fund Committee recommendation that the following be published by the Society of Petroleum Engineers and charged to the Fund income: 1) one instruction folder to accompany film, *Your Career in the Petroleum Sciences;* 2) one review folder for the same purpose; and 3) 6000 copies of booklet, *Careers in Petroleum Engineering.*

► Ernest Kirkendall has been appointed an AIME Pension Trustee.

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AIME NEWS

Around the Sections

• The **Lima, Peru, Section** held a luncheon meeting February 19 at the Hotel Bolivar. Following the luncheon, Erwin B. Jones, manager, Morrison-Knudsen del Peru, presented a film on *A Bounty of the Andes* which told the story of water and irrigation of Peru.

On March 26, another luncheon meeting featured Chester B. Cunningham, representative of the U. S. Navy at Minitrack Station near Ancen. His subject was *Tracking the Earth Satellite*.

At the April meeting Theodore Kiendl, Jr., managing director of Primadera Nepena S.A., spoke on how *Sugar Becomes the Byproduct*, the concern of the Nepana project.

• A testimonial dinner for William I. Smyth, 33 years a professor of mining engineering at the University of Nevada, was sponsored by the **Nevada Section,** the **Reno Subsection,** and the Mackay School of Mines on May 17. Professor and Mrs. Smyth were honored for their service to the school and to AIME, and Professor Smyth received a replica of the famed John W. Mackay statue as a token of the esteem of the nearly 200 friends who attended the retirement dinner in Reno.

• The **Washington, D. C., Section** held a dinner meeting May 6 at the Cosmos Club. Royce A. Hardy, assistant secretary of the Dept. of the Interior for Mineral Resources, discussed the minerals program of the department.

• The **Colorado Section** had a joint meeting with the Denver Petroleum Section on April 17. John R. Moran, moderator of the panel discussion, commented on the general subject *Objectives of College Education* and introduced the three panelists. Louis T. Benezet, president of Colorado College, spoke in favor of a liberal education, deploring the recent overemphasis on technical training as a result of Sputnik. John W. Vanderwilt, president of the Colorado School of Mines, added that the demands for both liberal education and specialized training will increase but that the college should not train only for immediate needs. William J. Yost, director of the Ohio Oil Research Center, was asked to represent the viewpoint of industry on the question of education. His remarks were in agreement with the other panelists.

The May 15 meeting featured Bruce Matthews, partner of Arthur Anderson & Co., Denver, who spoke on *Inflation and Business Profits*. A film accompanying the dinner meeting showed the relation of profits to inflated capital.

Replica of the famed John W. Mackay statue at the University of Nevada, Reno, was presented to William I. Smyth (right) at a testimonial dinner marking his retirement after 33 years service to the Mackay School of Mines. Vernon E. Scheid, Dean, Mackay School of Mines, makes the presentation.

• The **Reno Subsection,** Nevada Section, April 12 meeting was held in Gabbs to present papers on mining procedures used by two companies. A. M. Dixon, mine superintendent for Basic Inc., explained open pit mining by Basic. The use of fertilizer grade prilled ammonium nitrate in small blast holes by the Standard Slag Co. was described by mine superintendent G. B. Gaylord and mine engineer Mike Evasovic. Jay Carpenter, former dean of the Mackay School of Mines and director of the Nevada Bureau of Mines at the University of Nevada, related the early history of brucite and magnesite deposits. Section members attending were the guests for lunch of Basic and Standard Slag. At the business session John Butler, project engineer and research metallurgist, Mackay School of Mines, was given a special award for obtaining ten new AIME members in 1957. Eighteen students from Mackay School of Mines were guests at the meeting. After the program a tour was conducted of plants and mines of the two host companies. Wives of AIME members visited the Gabbs community library which they have helped stock with books.

• The May meeting of the **Reno Subsection** presented George Tunell, professor of geology at UCLA, who discussed the geology and mineralogy of Cripple Creek, Colo. The winners of the Student Contest were also presented and received their awards.

• The **El Paso Section** held a spring dinner dance on May 16 at the Del Camino Restaurant with cocktails, dinner, and dancing as the highlights of the evening.

• The **Morenci Subsection,** Arizona Section, held a joint meeting with the Arizona Section of the AIEE on May 6. David Orr gave a short summary of the Open Pit Division meeting and Ben Warriner, sales manager of industrial applications, computer department, General Electric Co., explained the basic principles of the analogue and digital computors in a talk entitled *Data Processing for Industry*.

The Southwestern Alaska Section held its annual banquet with a lecture on exploration in the Yukon, by Nicholas Gritzuk. From left to right are Mrs. Burton Anderson, Mrs. Karl Bachner, Nicholas Gritzuk, Burton Anderson who was master of ceremonies, Chairman Karl Bachner, and Mrs. Gritzuk.

• The **Southwestern Alaska Section** held its ninth annual banquet April 12, in Anchorage, Alaska. Guest speaker was Nicholas Gritzuk, transportation manager for associated companies engaged in mining and exploration work in the Yukon.

• The **New York Section** monthly meeting was held on April 24. One address was given by Robert L. Ziegfield, secretary-treasurer of Lead Industries Assn. He discussed the "exciting new developments" in the lead industry that establish lead as an important basic material in modern technology. J. L. Kemberly, executive vice president American Zinc Inst., outlined efforts to promote greater use of zinc. T. E. Veltfort, managing director of the Copper and Brass Research Assn., described some of the dynamic areas for expansion in the copper industry.

The usual (capacity) gathering of the New York Section met May 15 to hear J. M. Warde, mineral economist of Union Carbide Ore Co., discuss *Ores for the Ferro-Alloys.* Economic status, availability, and outlook for chrome and manganese were covered in a penetrating analysis. The speaker touched on highlights of Russian production, commenting that manganese use per ton of steel averages 70 lb in the USSR, as compared with the 14 lb used in the U. S. High sulfur content of Russian iron was blamed, but, even though that country has huge resources of the metal, research there is looking toward recovery from slag—probably as a safeguard for projected steel expansions. As for chrome, speaker Warde believed Russian exports would climb from the present 70,000 tons to 100,000 tons in the near future. The meeting was the last for this season. A September conclave will start the autumn sessions.

• At the April 10 meeting of the **Ajo Subsection,** Arizona Section, the following officers were elected: R. E. West, chairman; T. R. Herndon, vice chairman; and J. D. Gardner, secretary-treasurer.

The May 7 meeting was the annual picnic with WAAIME at the Ajo Picnic Grounds and the main business was food and fun enjoyed by all.

• The **Crucible Club,** Student Chapter of the Mackay School of Mines, heard Thomas W. Clapper, manager for research in the Henderson plant of the American Potash & Chemical Corp., at the April 1 meeting. Dr. Clapper described various research projects conducted by the Henderson plant.

• The **Ore Dressing Division** of the **Arizona Section** held a meeting at the San Manuel Copper Corp. on May 17. The morning meeting covered the operations of the San Manuel concentrator in a talk by the assistant superintendent, Harry Burke. A tour of the plant followed lunch and a dinner climaxed the program.

Reed F. Welch, manager, Southwestern Ore Purchasing Dept., American Smelting and Refining Co., has been appointed chairman of the Membership Committee of the Arizona Section, to replace A. T. Barr.

• On March 1 the **Colorado Plateau Section** held their annual meeting at Grand Junction to hear about the uses of atomic power in the railroad industry. An atomic engine is still in the future, but present-day devices that irradiate coal and oil have already saved fuel costs, the AIME members learned from Ray McBrien, research director for the Denver and Rio Grande Railroad. Mr. McBrien demonstrated safety improvements including a signal lamp that will last for years.

In addition, the members elected the following new officers at the March meeting: A. George Setter, chairman; Gilman Ritter, vice chairman; J. W. Hassler, vice chairman; T. S. Ary, secretary-treasurer; M. L. Jorgansen, Mark Shipman, R. L. Phillippone, and John Henderson, directors.

The Colorado Plateau Section had a successful field trip through the American Gilsonite Plant with John Henderson as host. A pre-tour discussion covered the operation and the pipeline from Bonanza to Fruita.

• The **Mexico Section** held a meeting at the University Club, Mexico City, on June 9. The principal speaker was Arman do Eguia from Petroleos Mexicanos, Exploration Dept., who discussed *The Seismological Exploration in Search of the Submarine Extension of the Faja De Oro.*

• **The Uranium Section** held its last regular meeting before the summer vacation on June 3 at the Towne & Country Club, Moab, Utah. The guest speaker was H. C. Conger, Hagan Chemicals & Controls, who spoke on *Water Treatment Problems.*

• **The Student Chapter** of the College of Engineering, University of California, received a projection screen at a luncheon jointly sponsored by the Chapter and faculty and staff of Mineral Technology on March 14. Lee Nugent, president of the Chapter, presided at the meeting which honored the memory of John W. Harman, whose family gave the screen as a memorial.

The activities of the Student Chapter this semester included a field trip to the San Andreas plant of the Calaveras Cement Co., a gold panning trip to the Mother Lode country, the semi-annual student-faculty steak fry, and the annual senior banquet held in May.

• The **Norwood Mining Society,** Student Chapter at the University of Kentucky, had an active semester of films and talks and a highly successful Engineers Day display of a model mine, gas chamber, fluorescent minerals, safety lamps, rock drills, and cyclone and rake classifiers in operation. The Old Timers Club Award, a gold watch, was presented to Alan Reed on May 8, at a dinner in his honor. Officers for the semester were Alan Reed, president; Clyde Storey, vice president; Donald Capelli, secretary; and Jack Lewis, treasurer. The year concluded with a picnic on May 17.

Charles Alan Reed (right), University of Kentucky mining engineering senior from Drift, Ky., was awarded a gold watch by the Old Timers Club in recognition of his outstanding record. S. M. Cassidy, vice president of Consolidation Coal Co., congratulates Mr. Reed. Mr. Cassidy was honored with a doctor of science degree, conferred by the university on May 26.

Hawaiian Holiday Awaits Post-Conventioners in San Francisco

When the nights are hot in August it's time to think of the cool, moonlit evenings, the refreshing surf and sand on the islands of Hawaii. Now is your chance to plan for the vacation that climaxes the Annual Meeting in San Francisco next February.

Hawaii offers exotic excitement and sheer relaxation. Native dancing and sumptuous feasts, the luau, will fill the cool nights with entertainment.

View the magnificent scenery from the cliffs of Mt. Tantalus and the Kalalau Lookout, where a breathtaking panorama includes the Napali Cliffs and the Valley of the Lost Tribe. Sugar cane and pineapple fields, acres of orchids, and regal volcanoes await the tourist. And at twilight the lights of Coconut Grove create a sight too lovely to forget.

There are historic sites and interesting tours, to visit Pearl Harbor or Nuuanu Pali where King Kamehameha defeated the Oahuans by pushing them over the precipice. And Honolulu itself offers the blend of oriental tradition and modern convenience for shoppers and nightclubbers. It is a vacation paradise of variety and splendor to fulfill everyone's desires. Take the time *now* to plan your holiday. See MINING ENGINEERING, July, p. 808, for details.

International Mining Days to Convene This Fall in Carlsbad, N. M.

The International Mining Days will be held in Carlsbad, N. M., on October 30 to November 1. The New Mexico Mining Assn. will join the Southwest International Mining Assn. under the chairmanship of R. G. Haworth for technical sessions and social events. Preparations are under way for a varied conference program with T. O. Evans in charge of the sessions, William Healy arranging the field trips, and E. C. Skinner planning the entertainment.

On Thursday a welcoming luncheon will follow registration and cocktails will end the technical sessions before a buffet dinner. Morning and afternoon sessions will occupy the men on Friday, with a luncheon and special meeting for the annual meeting of the New Mexico Association. The resolutions committee will give a report.

The ladies will be entertained while the men work and on Saturday all will be included in the ranch style breakfast, the field trips, and the suppliers' party.

Annual Meeting

(Continued from page 898)

The Mining and Exploration Div. will follow the program pattern set in 1958 to reduce session conflicts and promote presentation of topics of general interest so that miners, geologists, and geophysicists may attend each other's sessions. In addition to the joint sessions with SEG and IndMD the program so far includes the Jackling Award Lecture, an exploration symposium with four or five case-history papers, and a geophysics-geochemistry session. The mining units have scheduled sessions to cover open pit operations, safety and health, and three for general mining topics.

No report has yet been received from the MBD program committee. However, the committee is hard at work, and a resume of their activities will be forthcoming shortly.

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Personals

Bart Cox, who had been an engineer for the Canadian Gypsum Co. Ltd. at the Hagersville, Ont., plant, has been made superintendent of the Guelph, Ont., plant.

Paul Shapiro, formerly night foreman for Banner Mining Co., Tucson, Ariz., now is mining health and safety engineer for the U. S. Bureau of Mines-Health & Safety, Denver.

Norman Weiss, milling engineer, Asarco, has been named Utah program chairman for the American Mining Congress Convention in San Francisco, September 22 to 25.

The following officers have been elected to the Natural Resources Committee, Utah Chamber of Commerce Executives: president, **Norman Clayton,** general manager, Royal Crystal Salt Co.; vice president, **Thomas C. Clark,** comptroller, U. S. Steel's Columbia-Geneva Steel Div.; and secretary, **H. Wright Volker.**

E. B. Douglas, manager of Calera Mining Co.'s cobalt-copper mine in Cobalt, Idaho, has been appointed chairman of the Idaho state program committee for the 1958 convention of the American Mining Congress in San Francisco, September 22 to 25. The state chairman for Washington is **E. K. Barnes,** Spokane banker and president of the Northwest Mining Assn. **E. I. Renouard,** manager of mines for The Anaconda Co. at Butte, is the Montana chairman.

Daniel W. Cannon has resigned as executive secretary of the Bituminous Coal Operators' Assn. to join the National Assn. of Manufacturers' staff. The new executive secretary of the Bituminous Coal Operators' Assn. is **C. W. Davis** of Pikesville, Ky.

Charles J. Potter, president of the Rochester & Pittsburgh Coal Co., was elected to the Vitro Corp. of America board of directors.

John J. Sanford, senior field engineer for The Bunker Hill Co., retired April 1 after 48 years of service. He joined the Kellogg, Idaho, concern in 1908 after graduation from Colorado School of Mines.

John S. Owens, formerly Cuyuna range geologist for the M. A. Hanna Co., Crosby, Minn., is now geologist for Ozark Ore Co., Ironton, Mo., a Hanna operation. Succeeding Mr. Owens on the Cuyuna range is **Lawrence C. Trost,** a recent graduate of the University of Minnesota.

Blaw-Knox Co. announced the election of two new members to the board of directors. **John T. Ryan, Jr.,** president of Mine Safety Appliances Co. and chairman of Callery Chemical Co., and **Aiken W. Fisher,** president of Fisher Scientific Co., have joined the company's board.

Calvert Smith, formerly geologist for Appalachian Sulphides Inc., now works as geologist for the Hanna Coal and Ore Corp. in Brazil.

A. L. MORRIS

J. B. HOXIE

Dorr-Oliver Inc. announced the elections of **James B. Hoxie** as vice president for production and **Albert L. Morris** as vice president for company relations. Both have been directors of their respective departments.

Herman Gunter, state geologist and director of the Florida Geological Survey for more than 39 years, has retired. His successor is **Robert O. Vernon** who has served as assistant state geologist and associate director.

R. J. Wysor, formerly special consultant for the U. S. Steel Corp., is now international industrial consultant and is director and executive committee member, Dominion Steel & Coal Corp. Ltd. He has recently visited many iron and steel plants throughout the world. He resides in Virginia.

P. C. Benedict is on assignment by the Newmont Mining Corp. as consulting geologist to Tsumeb Corp. and O'okiep Copper Co. Ltd. in Southwest Africa.

Howard F. Bartlett, formerly an exploration geologist for the Marcona Mining Co., Lima, Peru, is now with the Utah Mining Corp., Riverton, Wyo.

Louis W. Ferguson has returned to Cia. Mineira do Lobito in Angola, West Africa, as director and techni-

SME Members Among Americans in Cuba Who Made Headlines in July

Photographs courtesy Wide World Photos

Guantanamo, Cuba, July 1958—*The rescued captives are welcomed back to civilization after their flight from a Cuban rebel hideout in Oriente Province, July 7. A Navy helicopter flown by Lieutenant Commander W. L. Greager picked up the men at the left: Eugene P. Pfleider, SME member and professor at the University of Minnesota; Roman Cecelia; Harold Kristjanson; Edwin S. Cordes; and John H. Schissler, SME member, engineer in charge of the Moa Bay Mining Co. Other Americans freed by Fidel Castro at the insistence of his brother Raul, are J. Andrew Poll and Sherman A. White, both SME members, and James P. Stephens. Mr. White is general manager of Nickel Processing Corp., Nicaro; and Mr. Poll is his assistant. These three were released July 7.*

personals

continued

cal consultant after freelance consulting work for the Upata Mines Inc., American Metals, and Kennecott Copper, among other companies. He had been technical director of the West African Company from 1951 to 1954.

Charles R. Lothrop, formerly serving as supervisor, has been appointed superintendent of industrial relations for U. S. Steel Corp.'s Oliver Iron Mining Div. in the Canisteo district.

J. E. Everts, formerly development geologist for the Phillips Petroleum Co. in the Strategic Minerals Section is now mining engineer in the Mining and Milling Dept.

Merlyn Woodle, Hibbing, Minn., has joined Reserve Mining Co. as assistant manager of the Babbitt Div. He has worked in copper, bauxite, and iron mining in the U. S. and West Africa and was superintendent of Minnesota Mines for Republic Steel Corp.

The merger of Lindsay Chemical Co. into American Potash & Chemical Corp. became effective May 1. **Charles R. Lindsay, III,** president of Lindsay Chemical Div. of American Potash, was elected a director and vice president of American Potash & Chemical Corp.

Wm. P. Crawford, retired, formerly general superintendent of the Copper Queen branch, Bisbee, Ariz., Phelps Dodge Corp., is now operating the Aztec Equipment Co. and the Crawford Diamond Drilling Co.

O. L. Briggs has been transferred from Salt Lake City as sub-branch manager to district manager for Chicago Pneumatic Tool Co. in Denver.

D. C. Sharpstone, consulting mining engineer and geologist, is acting for Frobisher Ltd. and Kilembe Mines Ltd. and is advisor and consultant to the Ethiopian Government for assessing the country's mineral potentials.

K. M. Dewar who had been manager of the Mining Dept. for R. M. Way & Co., is now vice president of Kilborn Engineering Ltd., Toronto.

W. P. Gillingham, who had been mine superintendent for National Lead Co. at Baxter Springs, Kan., has resigned to join the Mining Div.

W. P. GILLINGHAM

J. M. MACINTYRE

of Boyles Brothers Drilling Co., Salt Lake City.

William R. Coleman, Jr. is now a second lieutenant in the U. S. Army at Ft. Belvoir, Va. He had been a graduate student at the South Dakota School of Mines.

James M. Macintyre has been appointed to the post of master mechanic in the Milling Dept. of the Climax Molybdenum Co. mine at Climax, Colo. He had been employed as mechanical superintendent by the Britannia Mining and Smelting Co., B. C., Canada.

Victor Puskar of the Blocked Iron Corp. of America, formerly a research engineer, is now process engineer.

Roy M. Frisen who has been for five years manager of the Mexico Joint Venture, is now the president and general manager, Cia. El Carmen,

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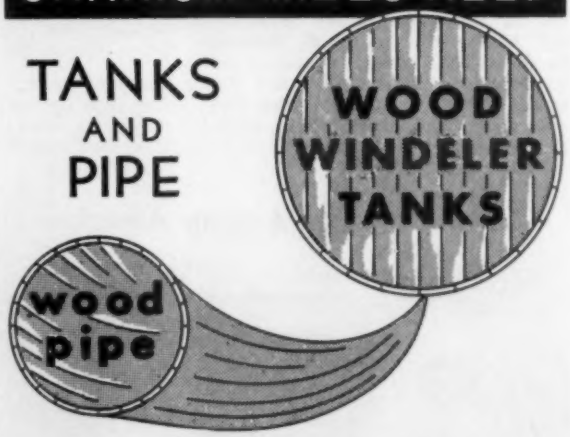

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South America. The joint venture financed dewatering and cleaning of two old Spanish silver mines.

Percy G. Dobson, formerly manager for the Summit King Mines Ltd., will carry on exploration in the U. S. from Vancouver for the Bralorne Mines Ltd. Summit King is a Bralorne subsidiary.

Donald P. Bellum is now a mining engineer for the Utah Mining Corp., Riverton, Wyo. He had been a student at the University of California.

Earl M. Cooper, who is associated with Mountain States Construction Co., has been made general superintendent of the Williamsfork Dam near Granby, Colo., after near completion of the Right Diversion Tunnel at the Glen Canyon Dam where he was project manager.

Dickerson R. Watkins, Jr., who had been assistant mine superintendent for the San Francisco Mines of Mexico Ltd., is now face boss for the International Minerals & Chemical Corp., Carlsbad, N. M.

Nicholas Chlumecky has extended his activities to include sales and consulting work in methods of ground support for mines. He was formerly a research engineer at Falconbridge Nickel Mines Ltd. and now is chief engineer at the Rockiron Co., Ltd., Sudbury, Ont., Canada.

A. F. Dunyon, sales engineer, is now with the United Specialties Co. of Illinois and is living in Minneapolis. He was formerly with the Eimco Corp. as sales engineer.

R. D. O'BRIEN

R. C. NORRIE

Robert D. O'Brien, who has been vice president and general manager of the Kenworth Motor Truck Co., Seattle, Div. of Pacific Car and Foundry Co., has been promoted to the position of vice president-sales of Pacific Car and Foundry Co. **Robert C. Norrie,** chief engineer at Kenworth, has been appointed general manager of Kenworth Motor Truck Co.

A. K. Boszhardt has been appointed supervisor, crushing machinery sales, for Allis-Chalmers Manufacturing Co., Milwaukee. He was an application engineer in grinding machinery sales.

The Washington Award has been presented to **Ben Moreell,** chairman

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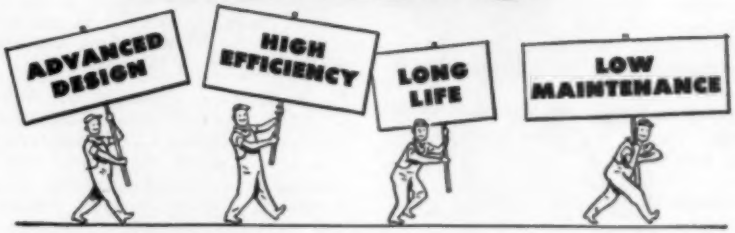

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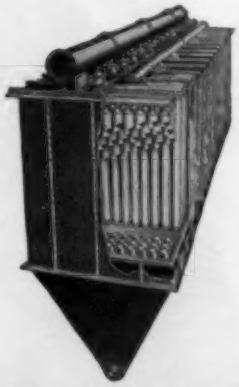

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personals

continued

of the board of Jones & Laughlin Steel Corp., Pittsburgh, for his "distinguished service as a skilled engineer, outstanding naval officer, industrialist, and Hoover Commission associate." The Washington Award is administered by Western Soc. of Engineers on recommendation of a commission representing the Four Founder Societies: ASCE, AIEE, AIME, and ASME.

The Oliver Iron Mining Div., U. S. Steel Corp., has appointed **Daniel G. Rukavina, Jr.** as safety supervisor of the Canisteo district and **Clifford M. Tinquist** as safety engineer.

Walter J. Williams, Duluth, formerly with Erie Mining Co.'s taconite plant construction project in Minnesota and now with Pickands Mather & Co.'s eastern Canadian ore interests, has been elected president and director of Newfoundland & Labrador Corp.

Paul J. Eimon has been granted a leave of absence from the American Smelting & Refining Co. for professional study and research abroad. He is expected to return in January. He and his wife are touring and studying all over Europe. Mr. Eimon is enrolled as a graduate student at the University of Tennessee and his field study work will be applicable toward a master's degree for which he completed most of the course work at the University of California. His fields are mineral economics and mining geology.

R. N. Hunt retired on May 1 as vice president and chief geologist of the U. S. Smelting Refining and Mining Co., but will continue as director of that company and on the board of the Hecla Mining Co. and is living in Salt Lake City.

N. S. McHarg, formerly of Wells Cargo Inc., is now general manager of Wells Overseas Ltd. Wells Overseas Ltd. is doing the general engineering and contracting for Pan American Commodities, in connection with development of the Acari Mine in southern Peru.

Albert B. Thaler, metallurgist at The Eagle-Picher Co., has been transferred to the Central Mill at Miami, Okla.

J. G. Huseby, consulting engineer, is now mill superintendent with the Homestate-Sapin Partners, Grants, N. M.

Max Y. Seaton, vice president of Food Machinery and Chemical Corp., has retired from active service but will continue as a consultant.

G. S. Preller, formerly with the Phosphate Development Corp., Transvaal, South Africa, has joined Cullinan Refractories Ltd., Pretoria, South Africa, as research officer.

Thomas A. Evans, formerly a metallurgist with the U. S. Bureau of Mines, is now mill superintendent at the Negociacion Minera Santa Maria de la Paz y Annexas in Mexico.

George R. Leland, mining and geological engineer, and **H. von Staufen** are presently doing consulting work in Medellin, Colombia.

G. S. PRELLER

S. S. COLE

Sandford S. Cole, assistant manager of research, Titanium Div., National Lead Co., South Amboy, N. J., has been elected to the board of trustees of Alfred University for a three-year term.

ROCKOVER

OPEN PIT SKIP SYSTEMS

- **Will elevate material at a lower cost per ton than any other system.**
- **Handle anything shovels and trucks will handle—no material too abrasive or blocky.**
- **Use only a few trucks in the pit.**
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Skips of from 5 - 35 ton capacities available. Write for information.

NATIONAL IRON COMPANY

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Wendell W. Fertig has returned to Denver to open a consulting office after resigning as executive vice-president of Western Nuclear Corp.

Chester M. F. Peters, consulting mining geologist, is making an examination of a gold property and of deposits of cement materials in Sudan for a local contracting company.

George L. Laughton is now superintendent of maintenance in the Reno, Nev., shop of the Isbell Construction Co.

Mr. J. A. Hartman, who was senior geologist for the Union Carbide Ore Co., is now production geologist for the Shell Oil Co., Bellaire, Texas.

W. R. Atkins, general superintendent of the Tungsten Mining Corp., is on loan from Haile Mine Inc. to the Aconic Mining Co., Montreal, as manager to carry on exploration work.

John M. Hoffman, who has been asst. to manager of the Andes Copper Mining Company, Potrerillos, Chile, is now assistant to the vice president of The Anaconda Co., the parent concern.

Charles J. Baroch is a second lieutenant in the U. S. Army Corp. of Engineers, having received his Ph.D. in metallurgy from Iowa State College where he was research assistant at the Ames Laboratory.

Stuart H. Levison, who has been vice president in charge of the Zinc and Coal Dept., retired at the end of April, after 46 years of service with American Smelting & Refining Co. Another long-term member, district traffic manager **Charles J. Baker** also retired.

I. Clyde Green was presented with a station wagon by his office staff at Mexican Zinc Co., American Smelting & Refining Co. subsidiary, when he retired in January.

John B. Wade, plant manager of the Eagle-Picher Co., Chemical Div., in Hillsboro, Ill. is now the plant manager of the Mining and Smelting Div. in Henryetta, Okla.

Leonard Wynn, who was a mining engineer for The New Jersey Zinc Co., Gilman, Colo., is now an engineering assistant for U. S. Gypsum Shoals, Indiana.

Joseph S. Malesky, who was subdistrict supervisor, Barbourville, Ky., for the U. S. Bureau of Mines, has been made supervisor of the newly formed District I, Norton, Va. A graduate of West Virginia University, he has been with USBM since 1942.

Eugene R. Goss, who was regional manager of the Chicago Pneumatic

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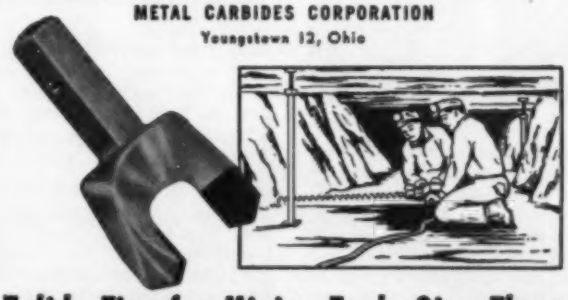

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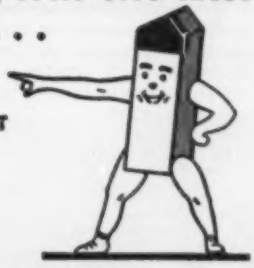

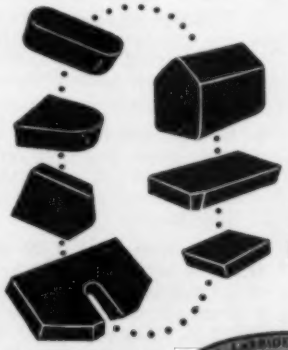

● A complete line of low-cost, high-quality Talide Tips is offered fabricators and users for tipping machine bits, rock bits, drill bits, roof bits and open-pit bits. All Talide Tips have a special surface finish that facilitates brazing. Non-standard shapes and sizes quoted on request.

personals

continued

Tool Co., is now with the Mining Div. of the Equipment Supply Co., El Paso, Texas.

Sheldon Jones has been appointed eastern sales manager for Hulburt Oil & Grease Co. of Philadelphia.

Otis M. McRae received an M.S. degree at the University of Mexico and now is field geologist for the American Overseas Petroleum Ltd. in Libya. Before entering graduate school he was a field geologist with the Atomic Energy Commission in Utah and Colorado.

S. JONES

O. M. McRAE

Donald C. Tretzel and **D. G. Farquharson** have been elected vice presidents of Kaiser Bauxite Co., Jamaica, B. W. I., wholly owned subsidiary of Kaiser Aluminum & Chemical Corp. Mr. Tretzel was works manager and Mr. Farquharson was the company's administrative manager.

Karl V. Lindell, vice president and general manager of Canadian Johns-Manville, succeeds **L. T. Postle** as president of the Joint Provincial Mining Assns. of Canada.

The American Standards Assn. has announced the names of the four delegates who will represent the U. S. on Technical Committee 27, Solid Minerals Fuels, of the International Organization for Standardization. The delegates are: **O. W. Rees,** Illinois State Geological Survey, Urbana, Ill.; **R. F. Abernethy,** U. S. Bureau of Mines, Pittsburgh; **C. R. Montgomery,** carbonization engineer, Pittston-Chenchfield Coal Sales, Cleveland; and **C. C. Russell,** manager, Gas and Coke Div., Research Group, Koppers Co., Pittsburgh.

The Arizona Society of Professional Engineers recently announced its new officers for 1958-1959. **C. Leroy Hoyt,** administrative assistant to the general manager, Ray Mines Div., Kennecott Copper Corp., has been named state president. **Harold W. Bishop,** chief engineer for the Ray Mine, Kennecott, has been named president of the Eastern Chapter of the society, and **Robert Winkle,** pit maintenance foreman, Ray, has been appointed secretary-treasurer of the Eastern Chapter.

Immo H. Redeker is now a mill engineer for The New Jersey Zinc Co. in Jefferson City, Tenn., after spending a year in Japan and Germany studying mining, ore preparation, and labor problems. Formerly he had been research assistant at the Climax Molybdenum Co.

Hans H. Stein has been promoted from general mine foreman to mine superintendent for the Northern Peru Mining Corp., Trujillo, Peru.

Among the men affected by the transfer of the Reynolds Metals Co. sales headquarters to Richmond, Va., are **Wilson D. Michell** and **John H. Moses,** both formerly at Little Rock, Ark.

Roy E. Peterson, formerly a development engineer for the Kaiser Aluminum & Chemical Corp., Spokane, is now mineral dressing engineer at the North Carolina State College Minerals Research Laboratory, Asheville, N. C.

Guy Browning has resigned as general superintendent of the Lorado Coal Mining Co. to return to Robinson & Robinson Mining Engineers, Charleston, W. Va., as consulting engineer.

Garnet T. Page, formerly general manager and secretary of the Chemical Institute of Canada, has been appointed general secretary of The Engineering Institute of Canada. He has been with the institute as assistant general secretary since the fall of 1957.

A. Lee Bennett has been named vice president in charge of production for Pacific Clay Products, Los Angeles. He had been vice president of research.

L. F. Rains is retiring as chairman of the executive committee of Joy Manufacturing Co., Pittsburgh, but will continue as a director of the company.

E. R. Johnsen has been appointed district sales manager of Marion Power Shovel Co. in Phoenix, Ariz., with a territory ranging from Idaho to New Mexico.

Frank F. Kolbe and **D. W. Buchanan, Jr.,** have been re-elected as directors of the National Coal Assn. Mr. Kolbe is president of The United Electric Coal Cos., Chicago, and Mr. Buchanan is president of Old Ben Coal Corp., also in Chicago.

Caesar Fulton, mining engineering student at Texas Western College, was awarded a $500 scholarship by the Chino Mines Div. of Kennecott Copper Corp.

Edmund McCarthy announces the establishment of an office at the Chanin Bldg. in New York as consulting engineer for the Guyan Eagle Coal Co.

Charles M. Brinckerhoff, president of The Anaconda Co., has been elected a director of the First National City Bank of New York.

Frederick C. Green, assistant general manager of the Utah Copper Div. of Kennecott Co., has been appointed general manager. He first joined Kennecott in 1917.

David L. Kuck, formerly office engineer for the Miami Copper Co., is now a mining engineer for the Kermac Nuclear Fuels Corp., Prewitt, N. M.

W. T. PETTIJOHN

W. McCULLOCH

Among the 68 executives who completed the course in management problems for executives at the University of Pittsburgh were **William C. McCulloch,** chief geologist, Southern Pacific Co., and **W. T. Pettijohn,** assistant to vice president, mining and exploration, The New Jersey Zinc Co.

Charles H. Lambur, chairman of Tekera International Inc. and president and general manager of Schneider-Paris Inc., left in June for Brussels to attend the exposition in the Atomic Energy Section of the French Bldg. by his Paris associates. In August he is presenting the annual American Challenge Trophy, Coupe Lambur, at the Monte-Carlo Golf Club, Principality de Monaco, before returning to the U. S.

James B. Cordiner, Jr., joined the department of chemical engineering at Louisiana State University as assistant professor, leaving his position as senior chemical engineer, research department, Kaiser Aluminum and Chemical Corp., Baton Rouge, La.

John W. Sheedy, mill superintendent for Appalachian Sulphides Inc., So. Strafford, Vt., has retired and is living in Spokane.

Joseph J. Yancik, formerly mine research engineer for St. Joseph Lead Co., is at the Missouri School of Mines, Rolla, Mo., on a research fellowship.

T. Reed Scollon, chief of the bituminous coal division of the U.S. Bureau of Mines, Washington, D. C., spoke

at a meeting of the Cumberland Engineers Club in Maryland this spring.

At a meeting of the board of directors of the Alpha Portland Cement Co., **Norman O. Wagner** of Easton, Pa., was elected senior vice president and the following vice presidents were chosen: **Ernest F. Brownstead, Richard L. Rhodes,** and **Joe D. Bell.**

Stephen P. Langa is engaged in recovery of metal from the slag and waste on the property of the National Tube Div., U. S. Steel Corp., Lorain, Ohio, as superintendent of the H. A. Stein Co. He had been superintendent of the Castalia Quarries Co.

L. WARE T. M. WARE

Thomas M. Ware has been elected president of International Minerals & Chemical Corp. to succeed his father, **Louis Ware,** who was elected chairman of the board and chief executive officer. At 39, Thomas Ware, former administrative vice president, becomes the fifth and youngest president of the corporation.

Three new members of the board of directors of the American Iron Ore Assn. were chosen at the annual meeting: **Arthur F. Peterson,** vice president of Bethlehem Steel Corp.; **M. S. Fotheringham,** president of Steep Rock Iron Mines Ltd.; and **George B. McMeans,** operations vice president of Kaiser Steel Corp. The following officers were re-elected: **Herbert C. Jackson,** associate managing partner of Pickands Mather & Co., Cleveland, chairman; **Franklin G. Pardee,** association staff member, president; and **Hugo E. Johnson,** association staff, former vice president, now vice president and secretary. Other officers include: **Harrie S. Taylor,** president, Oglebay Norton Co., vice president; **Walter A. Sterling,** president of Cleveland-Cliffs Iron Co., vice president; **Arthur B. Rathbone,** vice president-ore sales, Oglebay Norton, treasurer; and **George E. Guthrie,** secretary-treasurer of Oglebay Norton, assistant treasurer.

John S. Rinehart, assistant director of the Smithsonian Astrophysical Observatory and an astronomy research associate at Harvard University, will become a full professor of mining engineering at the Colorado School of Mines, Golden, Colo., this fall. He will also become director of the Mining Engineering Research Laboratory.

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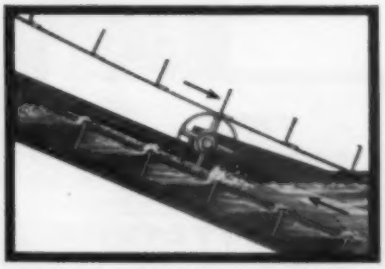
more efficient de-sliming . . . with the "OVERDRAIN" Classifier

The "Overdrain" Classifier is a completely new device in the field of mechanical wet classifiers. The belt, with lifting flights attached beneath, moves upwardly out of the sand bed between two stationary side shrouds—creating the effect of a series of moving, closed, washing compartments.



Section through "Overdrain" Classifier showing upward-moving, closed, washing compartments.

The only outlet from these compartments is via holes in the belt above. Surplus liquid and slimes discharge through these "overdrain" holes without mixing with the oncoming sands. The end result is an extremely clean sand discharge, excellent de-sliming—making the "Overdrain" Classifier an ideal washing device.

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Unretouched photograph of "Overdrain" action above the belt—water and slimes discharging upwardly.

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Obituaries

Roy W. Moore

An Appreciation By
George D. Dub

After a long illness, Roy W. Moore (Member 1920) passed away on May 18, 1958, two days before his 74th birthday. His illness was a matter of constant concern to his legion of friends in all branches of the mining industry as well as to his family. During this long period of suffering and inactivity it was heartening to all to note his wonderful fortitude.

Roy's active career in mining covered a period of 47 years dating from his graduation in 1906 as a mining engineer from the University of Arizona until illness forced his retirement in 1953. Almost continuously during this period he was associated with Harvey S. Mudd, Seeley W. Mudd, and Philip S. Wiseman. As a young man prior to 1913 he was employed as an assayer, surveyor, churn drill helper, and sampler at operations in Sonora, Mexico; Ray, Ariz.; and Bryan Mound Sulphur in Texas. Then came a period of mine examination work followed by his selection as superintendent and manager of Goodsprings Anchor Co. at Jean, Nev., until 1919 when there again followed some mine examination work.

In 1920, Roy went to the United Eastern Mine at Oatman, Ariz., as mine superintendent and upon retirement of John A. Burgess, he became the last general manager of that company. After the United Eastern Mine was exhausted, he prepared for AIME the very excellent paper *Mining Methods and Records at the United Eastern Mine* which appeared as Technical Publication No. 83, was presented at the New York meeting in February 1928, and was issued with *Mining and Metallurgy*, March 1928.

Indefatigable and faithful worker, Roy felt that time was of small moment where problems of mining, milling, geology, or just plain human beings were concerned. We, his associates, have sorely missed his company, his advice, his help since his retirement, and express the hope that for him, as also for Jim Bruce, for Harvey Mudd, for Web Wickes, there now is only high grade in large quantities.

Roy was a member of AIME and of the Mining and Metallurgical Soc. of America.

He is survived by his widow, Ruby C. (Childs) Moore; three daughters, Mrs. Charlotte Childs Pepper, Mrs. Annie Pauline Ross, and Mrs. Royda Clara Krumbein; a sister, and five grandchildren.

Edward L. Carow (Member 1933) died Dec. 22, 1957. He had retired in 1943 after an active career as a designing and construction engineer on a variety of projects in the east, the west, and in Chile, Africa, and Australia. At the time of his retirement he was working for Phelps Dodge Corp. Before that he had been resident engineer inspector for the U. S. Dept. of the Interior. He had begun his career as designer and detailer for various companies in New York from 1907 to 1909, then worked in Pennsylvania for the American Bridge Co.; in Chile for the Braden Copper Co.; and in Utah for the Utah Copper Co., as a designer for plant layout; steel, timber, and concrete structures; machine design; and power plant details. One of his interesting projects was the designing and constructing of a Pb-Ag concentrator, smelter, hoist houses, compressor plant, steam power plant, and other structures in Australia where he supervised the complete construction, incorporating novel features of his own in the plans. He was a university graduate, born in Newark, N. J., in 1883, and his wide experience qualified him for many supervisory jobs.

George G. Gallagher (Member 1934) died on Mar. 24, 1958, after an illness of several months. He was 58, and

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1933	John E. Hammell	May 8, 1958
1920	Roy W. Moore	May 18, 1958
1936	R. R. Nunn	Nov. 12, 1955
1954	G. W. Rathjens	Unknown
1916	Birdell J. Roberts	May 24, 1958
1917	Robert Wallace	Unknown
1951	Michael P. Walle	May 22, 1958
1901	Alexander N. Winchell Legion of Honor	June 7, 1958

acting as technical advisor to the Div. of Raw Materials, Atomic Energy Commission, in Washington, D. C., when he died. Mr. Gallagher was born in Leicester, Mass., but grew up in Colorado Springs, Colo., and graduated from the Colorado School of Mines in 1932. He was associated for a number of years with the United Verde Copper Co., Jerome, Ariz., and was superintendent of the Banner Mine, Lava Cap Gold Mining Corp., in 1936. During World War II he joined the staff of the Mining Div. of the Reconstruction Finance Corp. in Washington, D. C. He then spent a year in Mexico, and returned to Washington in 1949 for the position he held until his death.

Herman L. Griffin (Member 1921) died suddenly on Mar. 29, 1958. Born in Earlham, Iowa, in 1896, he received his degree in mining engineering from Carnegie Institute of Technology in 1923. He had been associated with Youngstown Sheet & Tube Co., Koppers Co., Hanna Coal Co., Heyl & Patterson, and Jones & Laughlin Steel as well as doing consulting work at various times. At the time of his death he was a valuation engineer with the Internal Revenue Service in Pittsburgh. His development of an electronic circuit breaker control led to a U. S. Patent for a safer-type control for the mining industry.

Victor H. Jones (Member 1952) died on Mar. 6, 1958. Mr. Jones was born in Sparta, Minn., in 1905 and received his B.A. degree from the University of Minnesota in 1926. He earned an M.S. at the State University of Iowa in 1928 and was a field geologist for the Illinois State Geological Survey and a graduate assistant in the geology department while he worked for his Ph.D. degree. He was an assistant professor at North Dakota State College when he received his doctorate in 1932. He worked for the Iowa Geological Survey, the Soil Conservation Service, and the Corps of Engineers, U. S. Army, as geologist concerned with sedimentation, in flood control operations, water supply and quarry development. At the time of his death he was in the Central Technical Unit of the Soil Conservation

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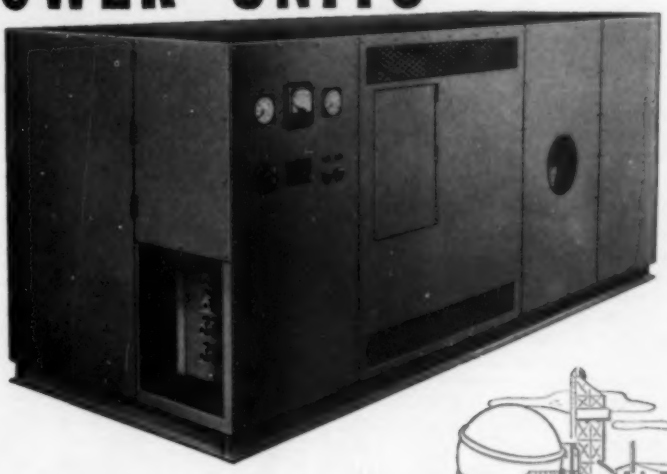

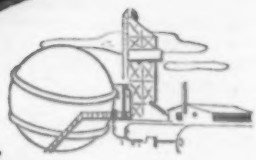

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Horace F. Lunt (Legion of Honor Member 1903) died on Aug. 10, 1957. He was born in Evanston, Ill., in 1875 and graduated from Harvard in 1898 and from Columbia School of Mines with an engineering degree in 1902. At that time he was assistant to the state geologist of Colorado. He did some general practice, consulting mining engineering and examination, and management of mining properties until 1916. He served as an officer of the field artillery during World War I. Mr. Lunt wrote articles on various subjects for mining journals and specialized in cyanidation and concentration. His latest activities in mining engineering were in Denver.

Norman E. Maclean (Member 1949) died on Nov. 2, 1957. Born in Salt Lake City in 1907, he received a B.S. in mechanical engineering at the University of California in 1932. From 1933 to 1948 he had been engineer, sales engineer, and sales manager for the southwestern division of American Manganese Steel Div. of The American Brake Shoe Co. in Los Angeles.

John N. Marshall (Member 1950) died in St. Louis on Apr. 16, 1958. He was born in Pittsburgh in 1897 and graduated from Lehigh University in 1920 with a B.S. in engineering. He worked for Koopers Co. Inc. and McClintic-Marshall Co. in Pittsburgh before joining Bethlehem Steel Co. in 1931. He left that company to become chairman of the board of directors, Granite City Steel Co., in 1949. Mr. Marshall was elected a director of the firm in 1935 and a president in 1950, serving in that dual capacity until 1956 when he was named chief executive officer. He was a director of American Iron and Steel Inst.; First National Bank in St. Louis; the American Zinc, Lead and Smelting Co.; Federal Barge Lines Inc.; and St. Louis Shipbuilding and Steel Co.

C. Wesley Potter (Member 1942) died Apr. 9, 1958 in Denver. He was born in Bridgewater, S. D., and attended the South Dakota State School of Mines where he received a B.S. in chemical engineering in 1935. Mr. Potter began his career as a city engineer in Deadwood, S. D., and a year later was dust laboratory assistant for the Homestake Mining Co., Lead, S. D. He obtained an M.S. and advanced to assistant mine safety engineer and mine ventilation engineer for the same company.

Walter A. Smith (Member 1950) lost his life in a tragic snowslide on Feb. 14, 1958, as he was trying to rescue others trapped by the avalanche. He was mine foreman of the Camp Bird Mine, Ouray, Colo. Mr. Smith was born in Bisbee, Ariz., in 1911 and has held positions in Venezuela, Bolivia, and Mexico. He was mine shift boss, acting mine superintendent, and then general mine superintendent for the Co. Huanchaca de Bolivia and the Cia Minera del Mexcala. In 1950 he was with Fresnillo Mines Ltd. and in 1954 he joined San Luis Mining Co., both in Mexico, before returning to work in Arizona and Colorado.

Eugene E. Whiteley (Member 1916) died on Mar. 19, 1958. Born in Minnesota in 1878, he graduated from the University of Minnesota School of Mines in 1903 and began his career as assistant engineer for the Calumet & Arizona Mining Co. He became assistant superintendent and then manager of the Tacoma plant, American Smelting and Refining Co. In 1943 he was mining engineer, Self-Liquidating Div., Reconstruction Finance Corp., Washington, D. C. For the last few years he had lived in California.

Edward Thorton died in Los Angeles on Apr. 20, 1958. Born in Philadelphia in 1897, he attended Lehigh University from which he graduated with an E.M. degree in 1901. He went to Mexico for the American Smelting and Refining Co., first as engineer and later as manager of various properties. He was at Nacozari for three years for Phelps-Dodge Corp., then became manager of the Asarco Twin Buttes property, and later manager of Imperial Copper Co. at Silverbell, Ariz. In 1921 he joined Southwestern Engineering Co. as a

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partner and served as vice president until 1931. In 1934 he was vice president of the Summitville Construction Mining Co. In recent years he was a partner in Union Engineering Co., examining and reporting on mining properties in Mexico and the U. S.

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Total AIME membership on June 30, 1958, was 30,162; in addition 3,064 Student Members were enrolled.

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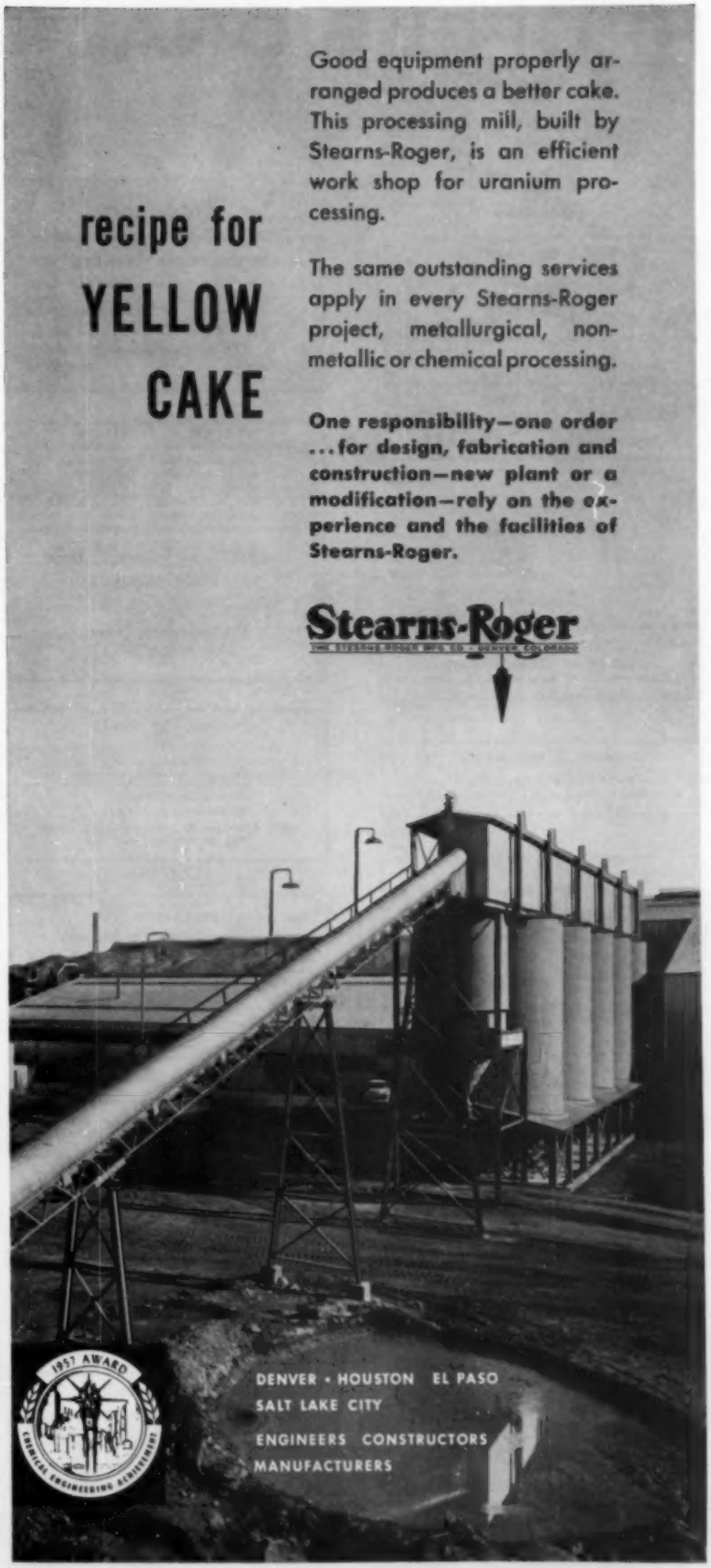
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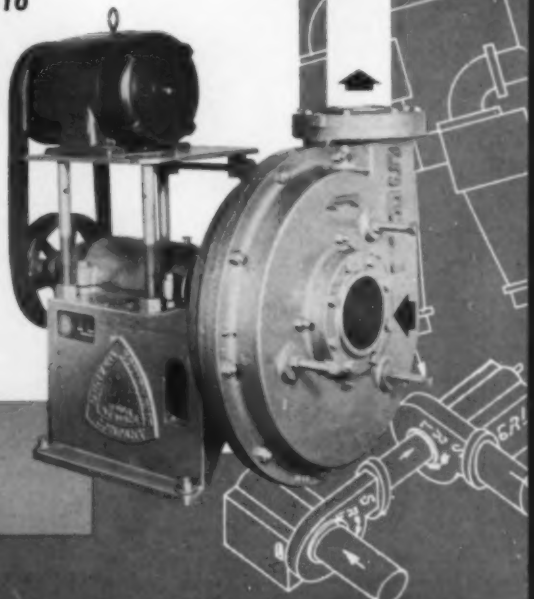

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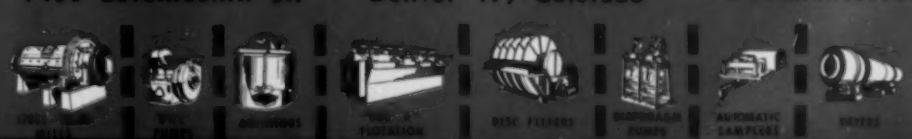

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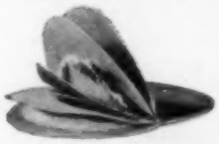

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